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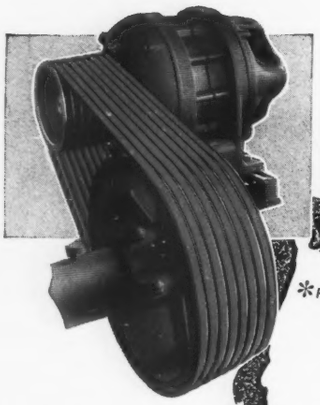

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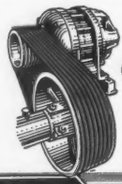

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INDUSTRIAL ENGINEERING

Founded in 1882 as Electrical Review. Consolidated with it—Western Electrician and Industry Illustrated.

Engineering and Maintenance in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

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Volume 88, Number 4

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The vacuum tube is at work in industry. It is sorting, inspecting, counting, weighing. Thus a new item has been added to the long list of equipment for which the plant engineer is responsible. In this issue we take our first major step in helping him to become familiar with its application. Van Brunt's article page 172.

Abstracts of Materials Handling papers begin on page 184. The papers were presented early in March at the time of the Management Congress, in Chicago.

Staniar "analryzes the sitchiation" in regard to power drive problems under favorable conditions—page 202. Next month he will give another analysis, dealing with power drive problems under unfavorable conditions.

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INDUSTRIAL ENGINEERING

Engineering and Maintenance in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

A McGraw-Hill Publication, founded 1882

Volume 88 CHICAGO, APRIL, 1930 *Number 4*

Yardsticks for Plant Engineering

. . . . . Every once in a while some leader in industrial thinking hits upon a happy phrase that condenses into a few words a truth that all of us immediately recognize as such.

. . . . . "Our industrial and social progress is no more rapid than our progress in transportation," says one. "Progress is directly proportional to our success in research," says another. And a third states that the development of communication is our pacemaker.

. . . . . These men have succeeded in defining the yardsticks by which our progress is measured. And of course they have rendered us a service in thus setting up simple standards by which we may measure general accomplishment.

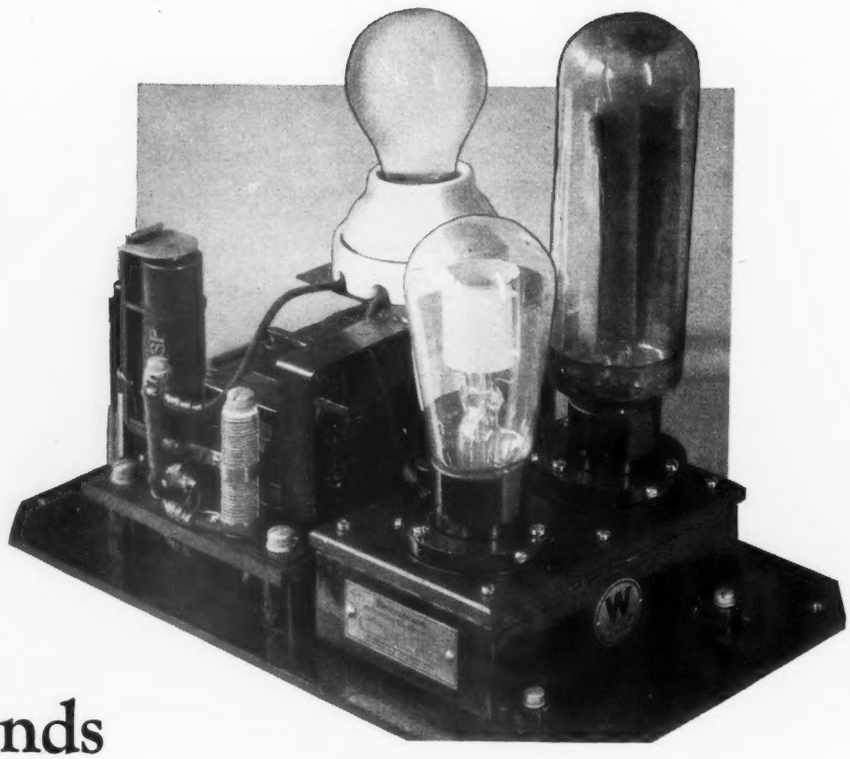
. . . . . In our daily work, however, we must be specific—we must have working gages. Some are crude, others are precision tools. In order to avoid waste the gage must be no more accurate than the product demands.

. . . . . What are the gages used in plant engineering? In maintenance? For the former, records. For the latter, records also, but physical measuring devices as well.

. . . . . With physical measuring devices every plant man is familiar. With records he is less well acquainted. Records of the performance of equipment are gages by which to measure qualities in the selection of additional equipment and to determine the time for preventive maintenance. Records of time required for specific jobs are measures of time to be allowed in setting job standards and preparing budgets. Budgets are gages by which to measure performance, and performance records are gages by which to establish budgets.

. . . . . All of these kinds of gages have been used for a long time by the directors of production work. They are being used more and more in plant engineering and maintenance. The nearer industry approaches complete mechanization the more important becomes the maintenance function, and the greater the necessity for being able to measure what it does and what it must do.

. . . . . Records make up plant history. Upon plant history are based the budgets for future production. Production, for its success, depends upon unfailing plant and equipment. The plant engineer is responsible for the maintenance of plant and equipment. In the interest of performing his function best he will record the history of the things he works with—that is, he will establish his gages or his yardsticks.



A photo-electric lighting control unit. At the right is the photo-electric tube, or light-sensitive cell. At the left the grid glow tube serving to amplify the output of the cell to operate the telephone-type relay. The small lamp illuminates the cell when the artificial light is off.

Industry Finds

ALADDIN'S LAMP— *The* VACUUM TUBE

By G. A. VAN BRUNT
Electrical Editor

WHEN some forgotten Oriental story-teller recited the exploits of Aladdin and his wonderful lamp, he displayed what was long regarded as unusual imagination. For hundreds, perhaps thousands, of years his tales have been the wonder and delight of old and young alike. Now it turns out that this ancient entertainer did not have enough imagination to describe some of the things that are being done daily in laboratories and industrial plants.

However, we do not summon up frightful genii, such as Aladdin commanded, to do our bidding; the infinitesimally small particles (if such they are) known as electrons are the genii inside the present-day vacuum tube that make it one of the most fascinating and useful tools that has so far been developed.

The principle of the vacuum or electron tube was discovered by Edison in 1883, when he found that a metal plate placed near a heated filament in a vacuum became blackened by the bombardment of tiny particles emitted by the filament. He also found that while the filament was heated a small current could be passed between the filament and plate.

One of the outstanding advances in the slow development of the vacuum tube was the introduction of a third element—the grid. This provided a means of controlling the action of the tube, for by giving the gride a positive charge the flow of electrons can be increased, resulting in a greater flow of current. Conversely, a negative charge, or bias, will retard or entirely prevent the flow of current.

Today, the modern vacuum tube provides a simple means of rectifying or changing alternating current to direct current, a means of amplifying very weak currents to any reasonable value, and serves also as a source of high-frequency oscillations. One or more of these characteristics have been utilized in adapting electron tubes to a large number of commercial and industrial applications out-

The photographs from which the illustrations were made are available through the courtesy of the Westinghouse Electric and Manufacturing Company.

side the field of radio communication.

Some of the most dramatic and intensely practical applications are based on the use of the photo-electric cell. This is simply a modification of the ordinary electron tube; one of the chief differences is that it does not contain the hot filament which serves as the source of electrons in the ordinary tube. The photo-electric cell consists essentially of two electrodes, the anode and cathode, mounted within a highly evacuated bulb.

The cathode is coated with some metal such as potassium or cesium that has the property of emitting electrons when light is allowed to strike it. If a potential of, say, 110 volts is applied across the terminals of the cell a current will flow between the anode and cathode when the cell is exposed to light. The current flow is in direct proportion to the intensity of the light. In the dark no electrons are given off by the cathode; consequently, there is no flow of current.

The photo-electric cell is strikingly similar to the human eye in many respects, but surpasses it in others. For example, cells are commercially available that will respond to any color of light from the red end of the spectrum to the violet end. All cells that respond to ordinary light will respond to ultra-violet light. Cells can be made that will respond to ultra-violet, but not to ordinary light. Other cells are sensitive to wave-lengths toward the far or outer end of the ultra-violet part of the spectrum, but not to the near ultra-violet, such as comes through window glass. It is likewise possible to make cells that will respond to light, or wave-lengths, beyond the red end of the spectrum, which are not visible to the human eye.

With cells of this wide range of characteristics commercially available it is evident that the field of application in which photo-electric cells can be used is extremely large and varied. Furthermore, development work is being pushed, and there is every reason to expect that cells with characteristics that are not now obtainable will be available in time.

Other Types of Photo-Electric Cells

In passing, it may be noted that two other types of photo-electric cells have been developed for commercial work. These are the electrolytic cell, and the well-known selenium cell, which changes its electrical resistance with changes in the intensity of the light falling on it.

The output or current flow of the vacuum-tube type of photo-electric cell is on the order of micro-amperes (millionths of an ampere), whereas the ordinary hot-filament tube passes currents that are measurable in milli-amperes (thousands of an ampere). The output of photo cells must, therefore, be considerably amplified before it is possible to operate control devices or other equipment.

In one of the commercial photo-electric cell units now available, what is known as a grid glow tube is used to amplify the output of the photo-electric cell. This tube is in itself a remarkable development or modification of the vacuum tube. It consists of a cathode, anode, and grid mounted in a sealed tube filled with neon gas. No filament is used. For a.c. operation the normal operating voltage is 440 volts and the normal operating current about 8 milli-amp. This is sufficient to operate a small relay that can handle 1 amp. or so at 110 volts. If heavier currents are to be controlled it is necessary to use a second relay having the desired capacity.

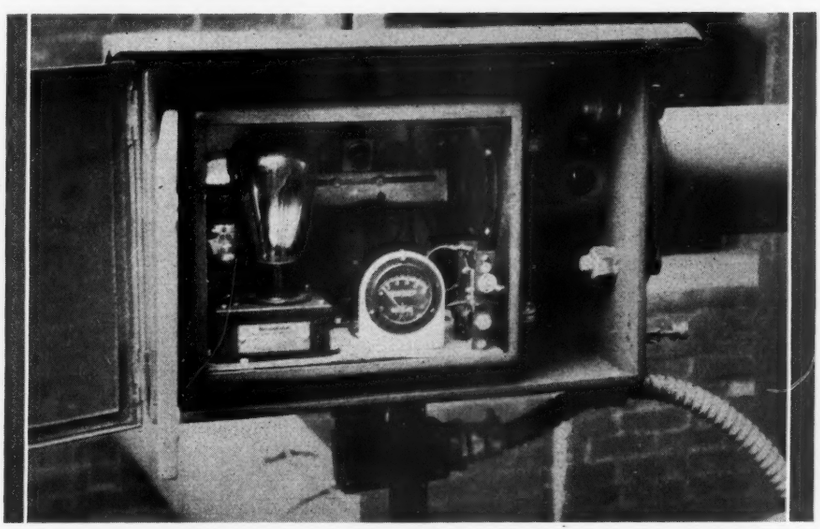
For d.c. operation 180 volts or more is impressed on the tube.

When the grid is insulated or free a heavy negative charge is built up on it, which prevents flow of current between the cathode and anode. However, a conducting path of very

APPLICATIONS OF LIGHT-SENSITIVE DEVICES

Light intensity measurement[1]	Floodlight control[1]
Printing photographs [1]	Inspecting material for flaws[2]
Daylight recording[1]	Automatic reversing of bar mills[3]
Elevator control[2]	Paddle and limit switches[3]
Fog height measurement[1]	Control shearing and other operations[2]
Detecting breaks in paper[1]	Block signal control[2]
Smoke recording[1]	Indicating train length (subway)[3]
Smoke detecting[1]	Indicating train speed (subway)[3]
(Fire alarm)	Safety signals and devices[1]
Soap indicator[2]	Traffic control[1]
Sodium hydroxide indicator[2]	Traffic counting[1]
Beaume gravity indicator[2]	Temperature measurement[2]
Fluid color indicator[2]	Demand limitator and indicator[2]
Paper or material color indicator[2]	Weight limitator and indicator[2]
Venturi meter[2]	Thickness indicator[2]
Counting objects[1]	Grading oils, dyes, etc.[2]
Automatic relaying[1]	Grading cigars, peaches, beans, etc.[2]
Lighting control[1]	Grading tile, pottery, etc.[2]
Haze indicator[2]	Burglar alarm[2]

[1]Actually installed [2]Contemplated [3]Recommended



Close-up view of the amplifier and control unit of a photo-electric smoke recorder. Light is reflected into this unit from a light source on the opposite side of the stack.

small capacity between the grid and anode is sufficient to drain off the negative charge and permit a current to flow. In the type of photo-electric cell unit under discussion the photo cell, when illuminated, provides the conducting path. The general scheme of connections is shown in one of the illustrations. In other applications of the grid glow tube a condenser may be used as the conducting path.

An ordinary hot-filament or thermionic type of vacuum tube having special characteristics may also be used as the amplifying unit with a photo-electric cell, in place of the grid glow tube.

In the photo-electric cell unit described in the preceding paragraphs the grid glow tube passes no current until the light on the photo cell reaches a predetermined value. For some purposes however, the reverse action is necessary; that is, the grid glow tube must pass current until the light on the photo cell reaches a certain intensity. This requirement can easily be met.

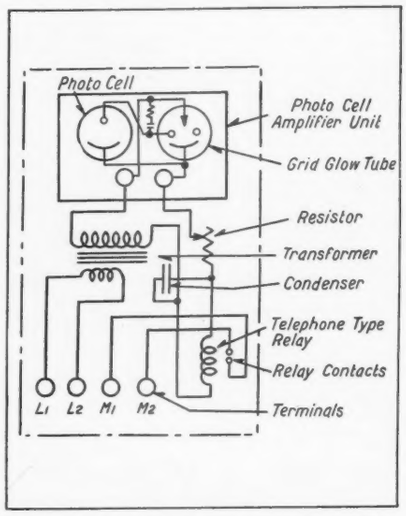
Two General Classifications of Industrial Applications

Practical industrial applications of the photo-electric cell fall into two general classes: (1) Those in which a simple on-and-off action is desired. (2) Those in which true measurement of the quality of light is required. The field in both of these applications is almost limitless.

One of the well-known applications in the first class is the control of artificial lighting in factories and offices, control of electric signs, street lighting, and so on. The photo-cell unit can be adjusted to operate at any light intensity up to about 20 foot-candles. When the intensity falls below the desired minimum the light control switch is closed through the action of the photo cell and opened when the daylight intensity rises to the desired value.

For most of the purposes for which it is used at present, the photo-electric cell unit is used in conjunction with its own artificial light source, which throws a continuous beam of light into the cell. Interruption of the light beam causes the photo cell to operate various kinds of devices.

Among the simplest of these applications is counting the packages on a conveyor as they pass a certain point. Vehicles, persons, or any moving object that is large enough to interrupt a small beam of light may thus be counted accurately at a maximum rate of about 300 per min. A magnetic counter operated by the photo-cell unit is employed to record the number of times that the light beam is interrupted. With a suitable light source the photo cell may be placed at any distance ranging from a few inches to about 14 ft. away.



Wiring diagram of commercial type of light relay employing a grid glow tube. It is operated from a 110-volt, 25- or 60-cycle circuit.

Another class of applications includes those in which the photo cell is employed to initiate certain operations such as ringing an alarm, or lighting a lamp when there is a break in the continuity of a strip of material, such as paper; controlling shearing operations; starting or reversing sheet or bar mills; opening garage or other doors; use as a limit switch; and use as a temperature control device.

The Photo-Electric Cell as an Indicator

In a third class of possible applications the photo cell serves as an indicator to show the position of doors, freight cars, or trucks in one-way passages or dangerous places, and so on.

Interruption of a beam of light is also the principle on which burglar alarm systems for guarding safes, vaults, and the like are based. When the light beam shining on a photo cell, which may be concealed, is interrupted the change in the electrical condition of the cell at once results in closing the contacts of a relay, which in turn operates an alarm. It is interesting to note that if the use of a visible beam of light is not desirable, a light beam that is not visible to the human eye may be employed just as effectively.

In the second class of photo-electric cell applications, in which measurement of, or discrimination between, different intensities or qualities of light is required, there are many interesting examples. The general principle employed in all of those applications is substantially the same: The variations in the output of the cell under different conditions of illumination is suitably amplified and employed to operate recording or indicating instruments or, through the medium of relays, to give an alarm or initiate any desired operation.

A Few of the Applications That Have Been Made

Of the rather long list of such applications that have been made, or are easily possible, only a few can be mentioned here. One of the simplest is indicating or recording the amount of smoke passing through a stack. For this purpose the beam of light from an incandescent lamp is passed through the stack and directed upon a photo-electric cell mounted on the opposite side of the stack. Variations in the amount of smoke in the stack are reflected in the amount of light that reaches the photo cell, which in turn controls the recording or indicating instruments.

Closely allied to this application is the use of photo cells as fire alarms. Their extreme sensitivity to the slightest change in the intensity of light falling on them makes possible the detection of minute quantities of smoke. A puff of smoke from a cigarette is sufficient to set off an alarm, start a sprinkler system, close fire doors, or perform any other operation.

Sensitivity to light changes is being utilized in two other applications that are of much interest to industrial plant men. One of these is the inspection and sorting of a wide variety of products, such as cigars, beans, yeast cakes, and so on, according to shape, size, or color. The principle of operation is to have the "electric eye" scan the objects as they pass beneath it on a conveyor and are illuminated by a suitable light source. Any variation in the quality or quantity of light reflected from them will cause the photo cell to operate a barrier or other device for removing or segregating all objects

that deviate from the fixed standard.

Of similar nature is the use of a photo cell to inspect the surface of highly-finished sheet metal, and perhaps other materials, for defects. Here again the slightest change in the amount of light reflected into the cell or cells can easily be made to stop a machine or conveyor, or otherwise give warning of defective material. This electrical inspection is not only more rapid than is possible with visual examination, but it completely eliminates such human frailties as fatigue and eyestrain that inevitably lower the accuracy and effectiveness of inspection work.

Not all of the possible uses of the photo-electric cell in industry can be discussed here, but a number of representative applications are listed with their present status in the box on page 173. New uses and applications are continually being developed; hence, it seems safe to say that this list, which represents the situation today, will require considerable modification within a year or so.

As noted previously, all of the applications of electron tubes so far mentioned involve the use of a photo-electric cell. There are, however, some industrial applications of vacuum tubes in which the photo cell does not play a part. Automatic leveling of high speed elevators by means of electron tubes is too well known to warrant discussion.

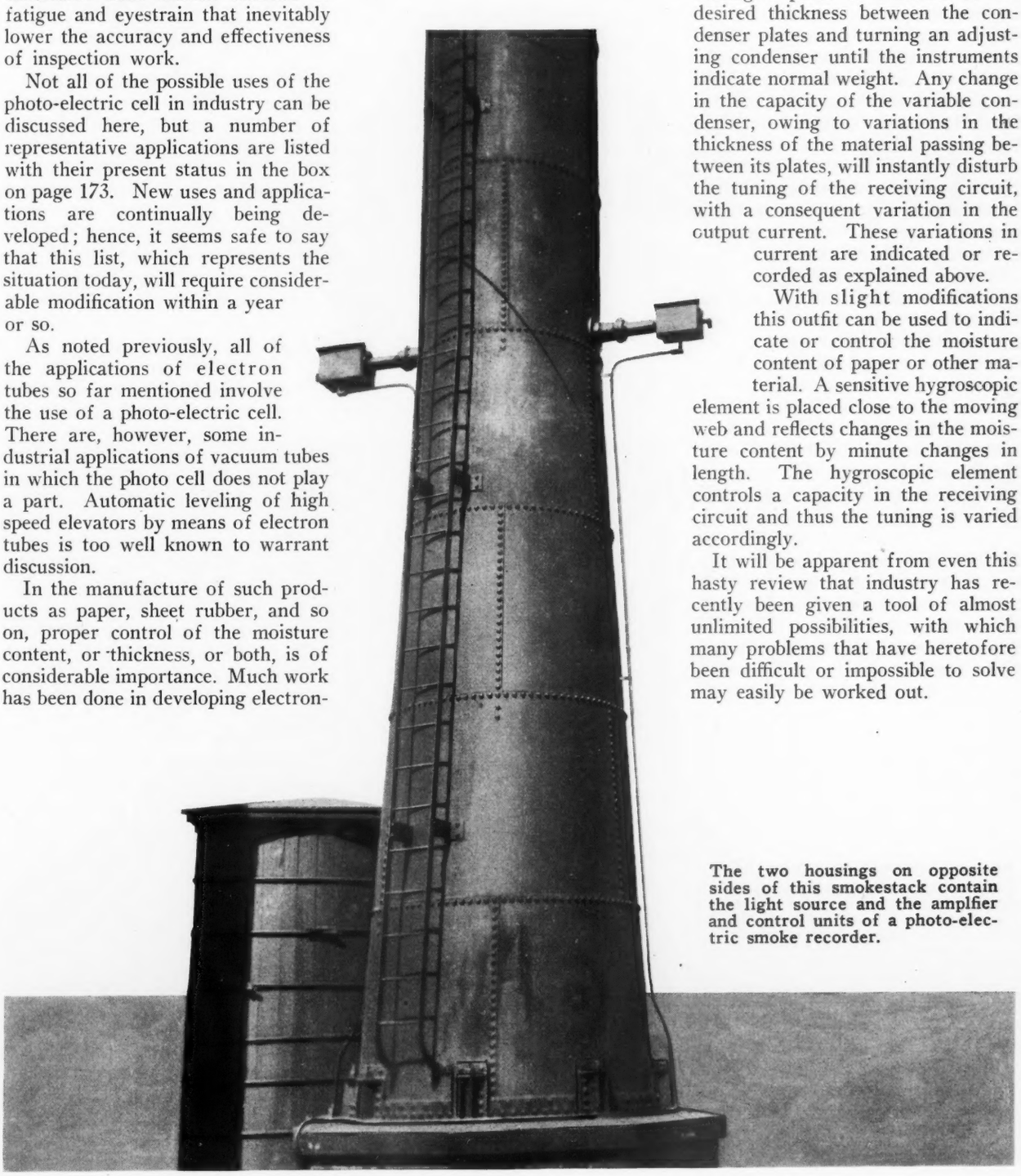
In the manufacture of such products as paper, sheet rubber, and so on, proper control of the moisture content, or thickness, or both, is of considerable importance. Much work has been done in developing electron-tube-operated devices, which are now on the market, for indicating and controlling the weight, thickness, or moisture content of sheet material. The apparatus consists of two main elements: (1) A simple sending station or oscillating circuit that emits a wave whose length is above those in the regular broadcast bands, and (2) an equally simple receiving circuit with the necessary amplifiers. Operation is based on the fact that the capacity of an electrical condenser varies with very slight changes in the kind or amount of material serving as the dielectric between the plates of the condenser.

The sheet of material whose thickness is to be indicated or controlled is passed between the two stationary plates of a condenser. This variable condenser is in the circuit of the receiving unit, whose amplified output actuates indicating or recording instruments, as desired.

The outfit is first calibrated by inserting a piece of material of the desired thickness between the condenser plates and turning an adjusting condenser until the instruments indicate normal weight. Any change in the capacity of the variable condenser, owing to variations in the thickness of the material passing between its plates, will instantly disturb the tuning of the receiving circuit, with a consequent variation in the output current. These variations in current are indicated or recorded as explained above.

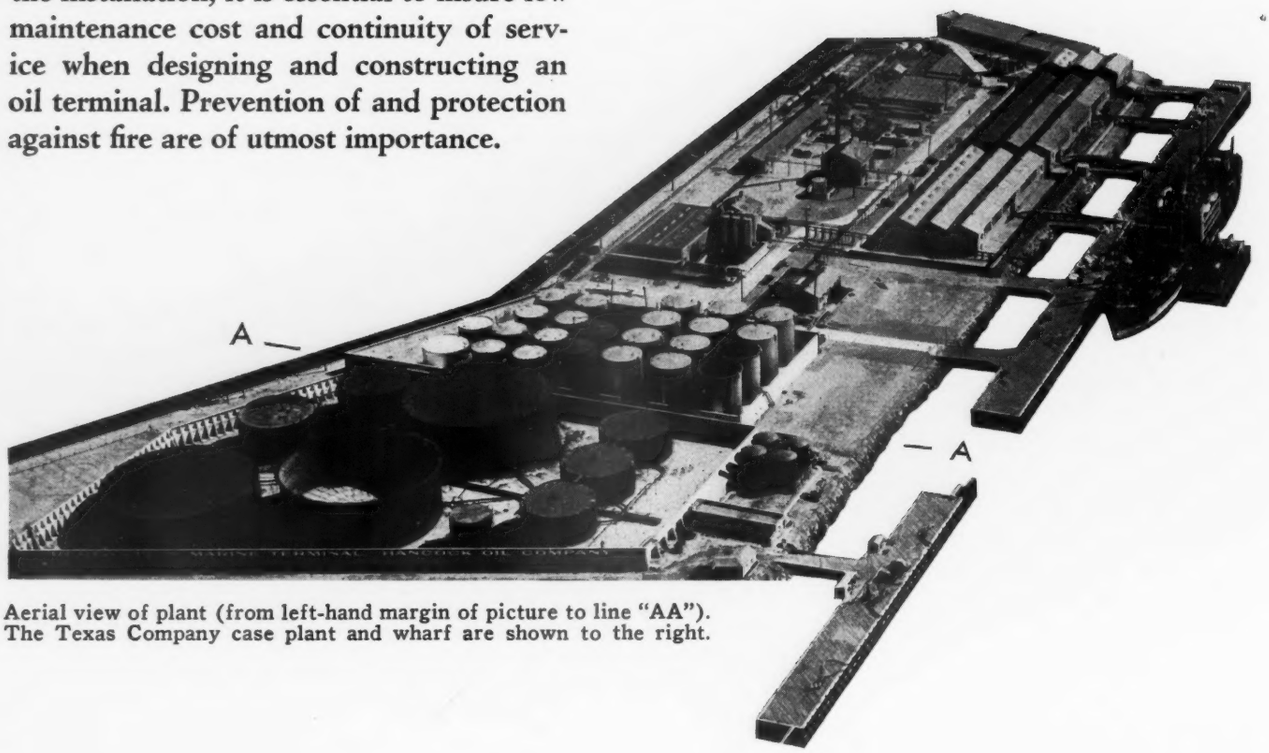
With slight modifications this outfit can be used to indicate or control the moisture content of paper or other material. A sensitive hygroscopic element is placed close to the moving web and reflects changes in the moisture content by minute changes in length. The hygroscopic element controls a capacity in the receiving circuit and thus the tuning is varied accordingly.

It will be apparent from even this hasty review that industry has recently been given a tool of almost unlimited possibilities, with which many problems that have heretofore been difficult or impossible to solve may easily be worked out.



The two housings on opposite sides of this smokestack contain the light source and the amplfier and control units of a photo-electric smoke recorder.

BECAUSE of the permanent nature of the installation, it is essential to insure low maintenance cost and continuity of service when designing and constructing an oil terminal. Prevention of and protection against fire are of utmost importance.



Aerial view of plant (from left-hand margin of picture to line "AA"). The Texas Company case plant and wharf are shown to the right.

How *Maintenance* Influenced Oil Terminal Installation

By M. C. COCKSHOTT

Mechanical Engineer
Hancock Oil Company
Long Beach, Calif.

IN the design and construction of the Hancock oil terminal, situated at Los Angeles Harbor, simplicity of operation combined with maximum flexibility and minimum maintenance has been the aim.

The plant occupies a six-acre tract of reclaimed land which presented, at the start, a difficult foundation problem. For the 80,000-bbl. tanks, which are the largest, excavations were made to a depth of 6 ft. Concentric with the excavation a 5/16-in. steel plate ring 137 ft. in diameter was set 2 ft. below the surface. At the base of the ring concrete with section 12 in. square was poured. Against this concrete ring 4x12-in.x 14-ft. tongue and groove sheet piling was driven. The base of the tank rests on a hollow cylinder of concrete with section 8 ft. thick and 3 ft. deep. Concrete pads were poured for the roof supports of the roof type tanks. The space between the concrete cylinder and the piling was filled to the level of the steel ring with quarry waste to a height of 4 ft. On top of the waste was placed two feet of well-rolled decomposed granite. For the 10,000-bbl. tanks the steel rings were dispensed with but the filled ground was excavated and the hole was filled with well packed quarry waste and decomposed granite. In order to take care of any inclination of the ground to fall away toward the water side, a bulkhead of 4x12-in. piles 15 ft. long was driven some 4 ft. below the surface of the ground and anchored to dead men.

Foundations for the 15,000-bbl. tanks were treated as were those of the 80,000-bbl. tanks except that there was no sheet piling or concrete used.

Owing to the care taken in the preparation of these foundations the tanks, on being loaded, settle 4 in. evenly all around.

The fire wall, of the Aston Step Type, is picturesque and is considerably more economical than the

solid type. In fact $10,000 was saved in constructing some 1,400 linear ft., because of low material requirement. The bays lend themselves to a variety of uses, the transformer house, tool room, paint shop, and service pump house being built into them.

Boiler house and all buildings except the office are of reinforced concrete. Steam, for heating coils in the tank farm, is supplied by a 150-hp. horizontal return tubular boiler. The setting of this boiler is so designed that, if needed, another boiler can be installed without interfering with operations of the plant.

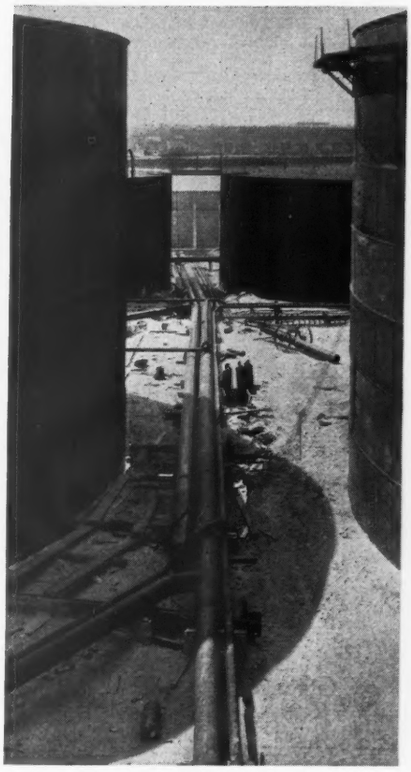
The pump house is sunk about 6 ft. below grade, so that all lines drain to the pumps, giving a flooded suction on one side and a low point for drainage on the discharge side. Floors of pump house and motor house are made of concrete colored with hematite. They present a clean and workmanlike appearance and no trace of oil or grease is apparent. Utmost flexibility is obtained in the arrangement of piping, whereby 9,000 bbl. of oil and 14,000 bbl. of gasoline can be handled per hour. Practically all pipe joints are welded and in the reduction of pipe sizes, all swages were made by means of the acetylene torch. Tests disclosed only two leaks in welds in the whole tank farm. There are no screw flanges to cause trouble, the only flanges being of the cap type.

Owing to the fire hazard all valves are of the cast-steel, rising-stem type with removable seats. This feature makes the overhauling of valves a comparatively simple operation. In order to cut down on future maintenance each valve, after being given a hydrostatic test, was opened and all scale and debris were removed.

To take care of the settling of the tanks, sleeve couplings were installed in those pipe lines which were connected to the tanks. The over-shot pipes were cut and rewelded after the settling had taken place.

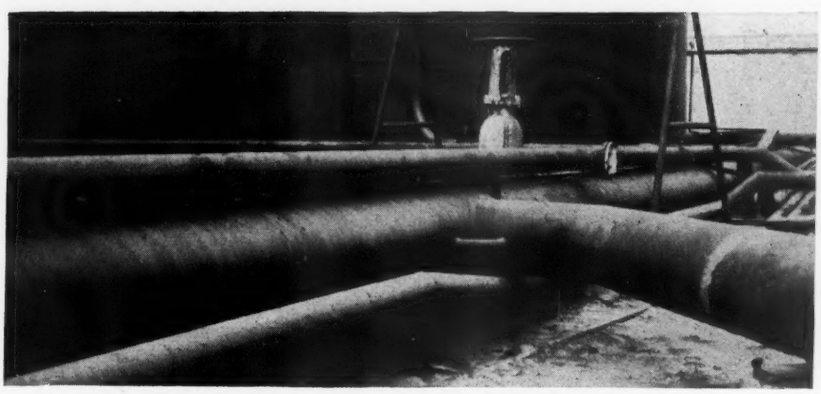
To avoid any chance of breakage, no pipe is fastened to the wharf. All piping from 1 to 18 in., is suspended from deck stringers, everything being underneath the deck yet accessible by means of substantial board walks.

For handling the hose, a mast with derricks is installed on the dock. It is bolted to a flange in such manner that it can be revolved by means of an air motor.



Construction of piping that is used in the tank farm.

Welded, swaged reduction joints, 20- to 16-in. pipe. Also welded joints in bends in 6-in. pipe lines.



Examples of welded joints connecting 20-in. and 16-in. pipes.

The main oil and gasoline lines are 18 in. in diameter, reducing to 16 in. and then to 8 in. at the loading nozzles. The bunkering line is 8 in. in diameter, reduced to 6 in. at the nozzle.

Steam is supplied by a 5-in. line insulated with 85 per cent magnesia, covered by 15-lb. asphalt paper wired every six inches.

Condensate from all traps is returned to a central hot well which is so arranged that the vapors assist in heating the make-up water from the city main.

The piping in the steam line was to have been welded but, to conform to a city ordinance, Cranelap joints were used instead.

The loading pumps are of the single-stage, centrifugal type, excepting the one used for bunkering, which is of the two-stage type. Drainage from each pump is carried in a central pipe which discharges into a sump.

A service pump is cut in on all oil lines to drain them and discharge to any oil tank through any of the main supply lines. This pump is also used to force a way through any ship's lines that may be clogged before the main pump is cut in.

A smaller pump, designed to feed gasoline in small quantities, is cut in

so that it can drain all gasoline suction and discharge lines.

Being on the water's edge, corrosion must be watched closely; therefore the paints used all around were most carefully selected to withstand the action of salt air.

For preserving the piping, both in the farm and on the wharf, the lines were first given one coat of a selected primer, then two coats of petrolastic cement applied hot.

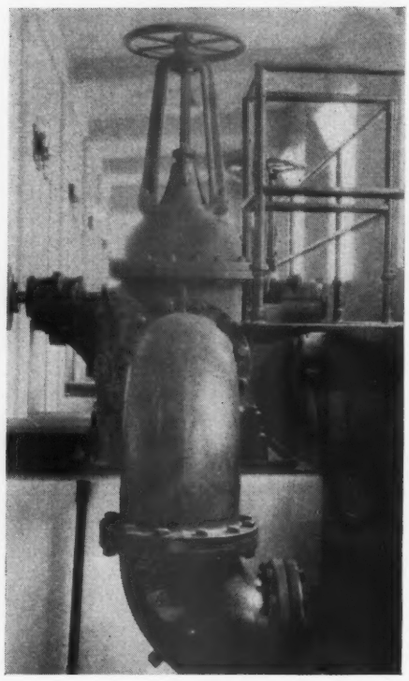
The piping in the valve pit is painted with a black graphite primer with an enamel covering coat.

In order to prevent corrosion on the tank bottoms, three 2-in. pipes equally spaced were installed in the foundation. These lines are connected to the manifold of a service pump whereby oil under 200-lb. pressure may be pumped into the bases, saturating the ground. Provision is made for salvaging the oil found in the slop and ship's ballast. This oil can be skimmed off if water is present and either returned to a fuel oil tank or used as a preservative for the tank bottom.

Because the mill scale was still in evidence in places the tanks were well scraped and wire-brushed before a coat of red graphite was applied. Where loosening occurred, the places were again scraped and primed. The tanks were then finished in aluminum. The tanks had been tested with salt water, hence all traces of salt had to be removed.

All electric conduit is sherardized, and all lamps, plugs, and fittings are of vapor-proof type.

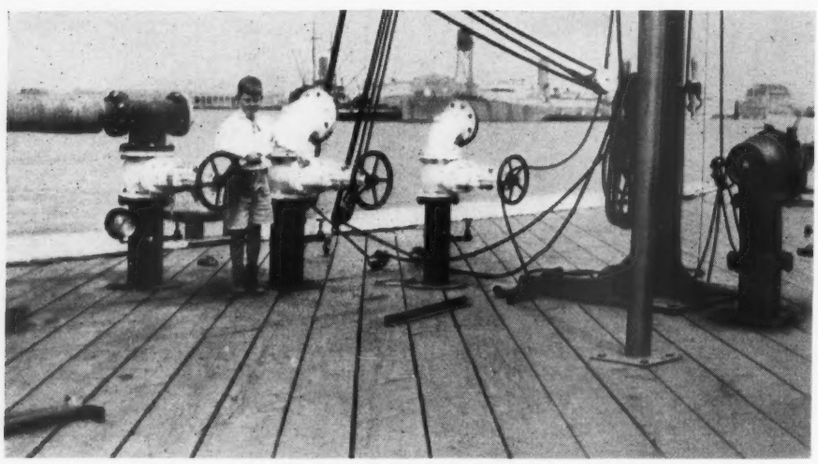
Every precaution is taken to prevent a fire. A steam line runs from the boiler room to the dock to service ships loading gasoline, since no fires are allowed on board at such times.



Side view of 4,500-bbl.-per hr. oil pumps, showing suction entrance.

To light ships when loading gasoline current is supplied through special, vapor-proof plugs located at the two ends of the wharf. The switchboard, with the compensators and relays, is in a recess in the motor room with the main disconnects installed above the compensators. All bunkering lines are connected to a common ground to which the ship itself is firmly grounded.

All pumps are driven by motors, with a firewall between them, thus putting the motors in a separate room. These pumps may be stopped at the switchboard, in the motor room, by remote control in the pump room, or on the wharf.

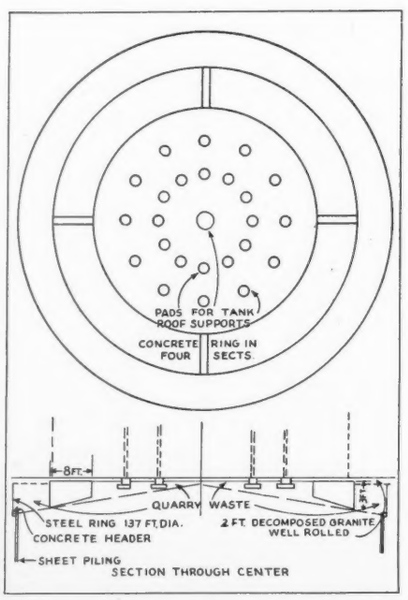


Loading nozzles, one 8-in., one 6-in., one with 4x4x8-in. tee for use with 4-in. hose. Hose-lifting hoist is shown at right.

Fire protection is provided by means of a 1,000-g.p.m., dual, motor and gas-engine-driven pump. This unit pumps a solution of acid and alkali from a combined 200,000-gal. source. All valves, pipes, fittings, and tanks on the acid side are lead-lined to resist corrosion.

Plant grounds are landscaped with a system of flagstone pathways with a moss grass growing in vacant spaces and shrubs around the office. This landscaping in an oil terminal may appear to be a novel feature but the small amount of labor required for its upkeep is more than compensated for by the improved general appearance. Also the moral effect on those whose duty it is to keep the yards clean and orderly is noticeable as it is seldom that anything is ever found out of place.

The plant is so designed that it can be run with a minimum of help. Normally the staff has a superintendent and three shift engineers. When needed, help is obtained from the refinery which is only a short distance away. When loading, one man is on duty in the pump and motor house and a helper is stationed on the wharf to watch hose and keep an eye on miscellaneous details. When the power plant is running to heat oil or to service ships a responsible engineer is on duty all the time.



Section of foundation for 80,000-bbl. tanks.

Beyond the repacking of occasional glands the cost of upkeep in the terminal should be negligible for a considerable period of time.

Suitable Protection Keeps Motors on the Line

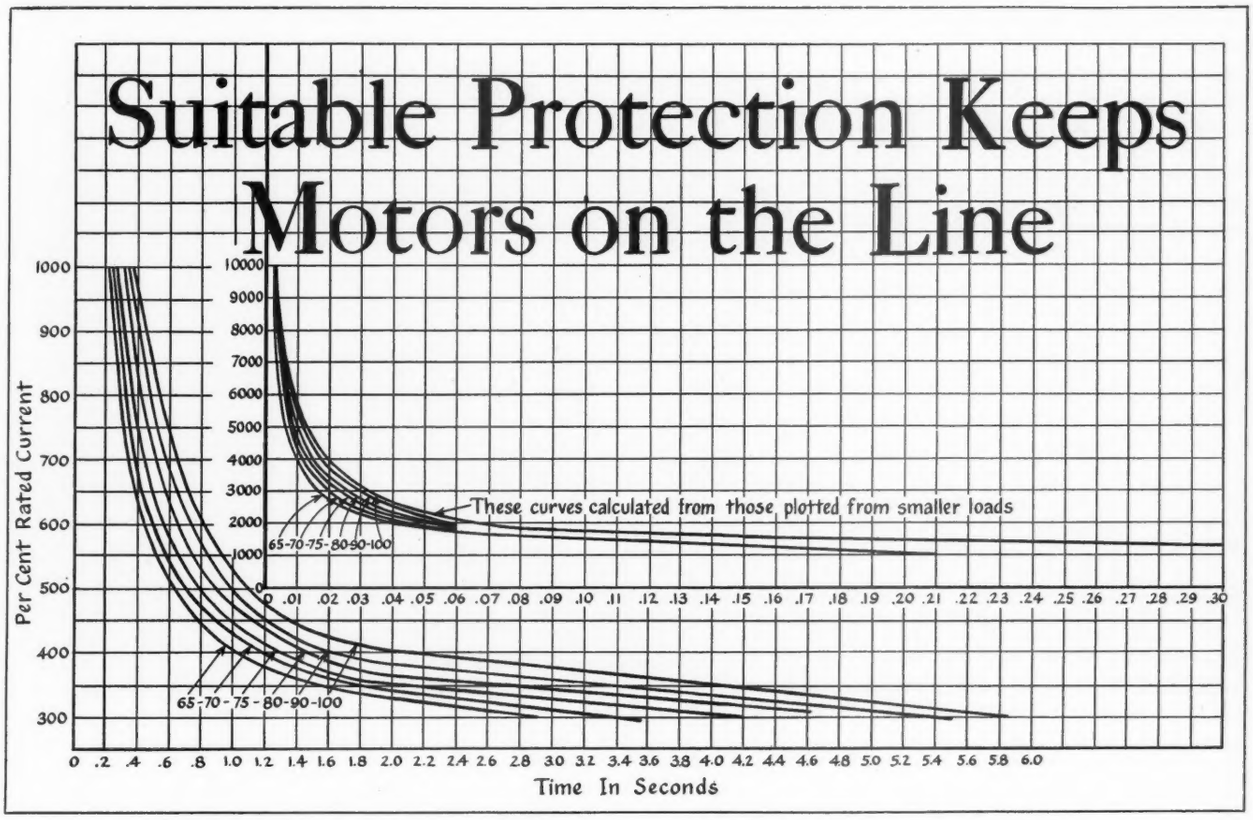


Fig. 1—Time-current curves of 600-volt fuses varying in size from 65 to 120 amperes.

By B. W. JONES

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Schenectady, N. Y.

IN any installation each motor and control should have adequate protection and, to satisfy this point each type of application should be given consideration to determine what type of protection is needed. A direct-current series motor on the hoist motion of a crane may need protection against excessive torque which may strip gears and let the load fall. It is quite likely that an induction motor on this kind of load will not need torque protection because the maximum torque will probably not cause trouble. Then again, a motor driving a pump in some out-of-the-way place should be protected against excessive heat.

In plants such as steel mills and plate glass factories, it is essential that trouble at one place shall not cause power failure and thereby shut down all motors. At each point where a connection is made to take power from the line, there is a probability that a short circuit may occur; therefore, it is essential that the power line be protected, and excessive damage to the control, motor or wiring, prevented.

It is the purpose of this article to suggest suitable protection to low-voltage motors and control, inasmuch as high-voltage motors are usually large motors and it is not so difficult to provide adequate protection for them. The control and protective equipment for small motors must be small and inexpensive and yet entirely effective. Emphasis, therefore, will be put on the protection necessary for low-voltage motors (600 volts or less) which, in the main, are small motors.

Torque Protection

Applications needing torque protection are those which are likely to have excessive loads or may become stalled, and where the motor is capable of developing very high torques. In general, only d.c. motors, and especially series motors, come in this classification.

To have torque protection the devices used should function with the least possible delay. The time required for an "instantaneous" overload relay to function depends upon the amount of current flowing through its coil and upon the type of the relay, but in general one-thirtieth of a second or less could be assumed. If the relay is governing contactors, it can be assumed that the contactor will open in one-twentieth of a second. Therefore, the total time interval after the fault would be approximately one-twelfth of a second.

For d.c. motors the adjustment of these overload relays should be just above the accelerating and load peaks. The setting which is usually applicable, is from two to two and one-half times the current rating of the motor. It should be kept in mind that this type of protection will not protect against excessive temperatures which will occur if the motor is run for a long time on a load that is between the motor rating and the torque relay setting.

Heat Protection

Practically all motors that run for long periods of time (an hour or more) need overload protection to keep them from overheating. It is a general opinion that motors which are driving loads such as centrifugal pumps or fans cannot become overloaded because the unit cannot re-

quire more power than the rating of its motor. If the motor is a polyphase, a.c. motor, the voltage may decrease causing the current to increase proportionately because power equals volts times amperes. Also, one of the power lines may become opened and cause the motor to run single-phase. The current drawn under single-phase operation is at least one and three-quarter times the three-phase current. The loss and, therefore, the heating in the motor varies as the square of the current which means that the rate of motor heating when operating single-phase is three times the multi-phase rating.

It is commonly thought that the rate of heating on a multi-phase motor when operating single-phase is greater than that caused by the same current in all of the phases. If only two of the three-phase windings of a three-phase motor are being heated, the whole motor will have a slower temperature rise. Since it is difficult for the heat to get out of the copper through the insulation it cannot be said that the temperature of the active winding would be two-thirds of that when all the phases were active, but it will be less than the three-phase condition.

A direct-current motor is also affected by a reduced voltage. Under certain conditions the field may become weakened which will cause increased heating in the armature. Therefore, as stated previously, all motors which run for long periods should be provided with overload protection.

Some years ago it was the practice to use a solenoid which was retarded by a dashpot or bellows to provide overload protection to motors. Of course, this device did not possess the same heating characteristic as the motor, and it could not compensate for the previous heating of the motor. Fundamentally, an overload relay must be actuated by heat if the best effect is to be obtained.

To give the results desired it is necessary to use the correct size of temperature overload relay. When a temperature overload relay is given a current rating, it means that the relay will trip at this rating after an hour or more providing the temperature of the air is 40 deg. C. If the ambient is 20 deg. C. instead of 40 deg. C. it will take ten or fifteen per cent more current to trip the device. The reason that the relay is rated in a 40 deg. C. ambient is because the motor is similarly rated.

To select the correct size relay which has been so rated, to protect a motor which is rated on the basis of 40 deg. C. rise, the relay should have a current rating that is fifteen per cent above the current rating of the motor. If the motor is rated on the basis of 50 deg. C. rise then the relay rating should be about five per cent above the current rating of the motor. If the relay is located in a material different from that of the motor, the relay should be selected or adjusted to compensate for the temperature difference found. A 20-deg. C. ambient difference means 10 to 15 per cent difference in current.

Most temperature overload relays have been designed for protecting open-type motors. If an open-type motor is inclosed it has to be de-rated to one-half or one-third of its open rating. This means that when inclosed and the diminished current is applied, it will take several times longer for the motor to reach its rated temperature because the heating rate varies as the square of the current. There is, however, a type of inclosed motor, known as the "totally-inclosed, fan-cooled" motor, whose inclosed rating is nearly as high as its open rating.

If a temperature overload relay is to be used as a means of protection to an inclosed motor of the type which is materially de-rated below its open value the same rule should be used as outlined for the open-type motors. However, it should be noted that since relays are designed primarily for open motors, the relay will reach a constant temperature long before the motor reaches its corresponding temperature. There are some loads which utilize the major thermal capacity of the inclosed motor where heavy overloads are carried for part of the time such as on the hoist motion of a crane or on the different motions of an ore bridge. The ordinary type of temperature overload relay will not function correctly with this type of motor and load because the relay will take the motor off the line too soon.

The application of overload protection can be expressed in a general rule as follows: "A standard temperature overload relay will give good overload protection to all open-type and to all totally-inclosed, fan-cooled motors (if they are made in accordance with accepted standard practices)." The same type of relay will give practical protection to the ordinary inclosed motor if its usual load does not materially exceed its continuous rating. This type of relay will not give a good working protection to an inclosed motor if the load current materially exceeds its continuous rated current for intervals of several seconds or more.

All sizes of motors are connected to a power supply in conjunction

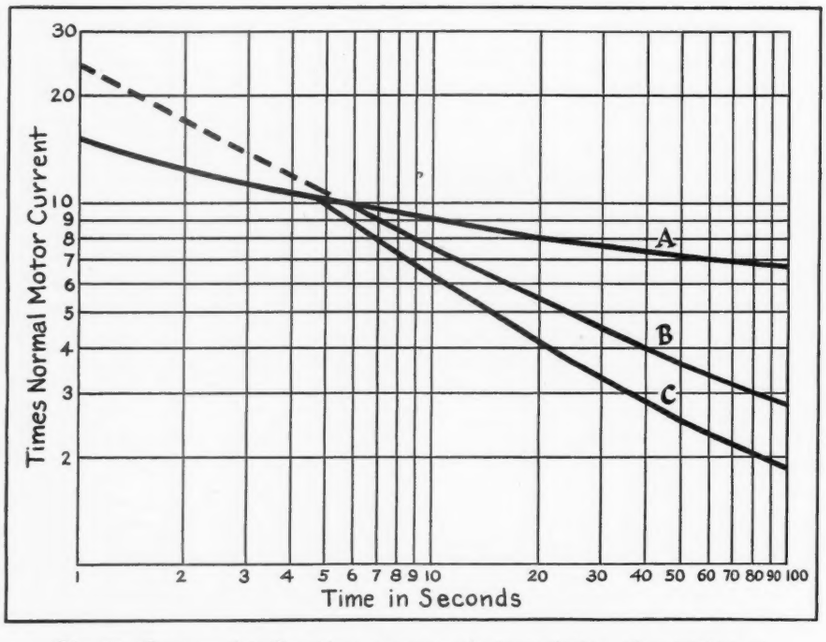

Fig. 2—Curves showing time-current characteristics of a motor, a relay, and a fuse. Curve *A*—Blowing characteristics of a fuse whose rating is four times that of the motor. Curve *B*—Time to heat a representative motor winding to its rated temperature. Curve *C*—Tripping characteristics of a TC-121C temperature overload relay.

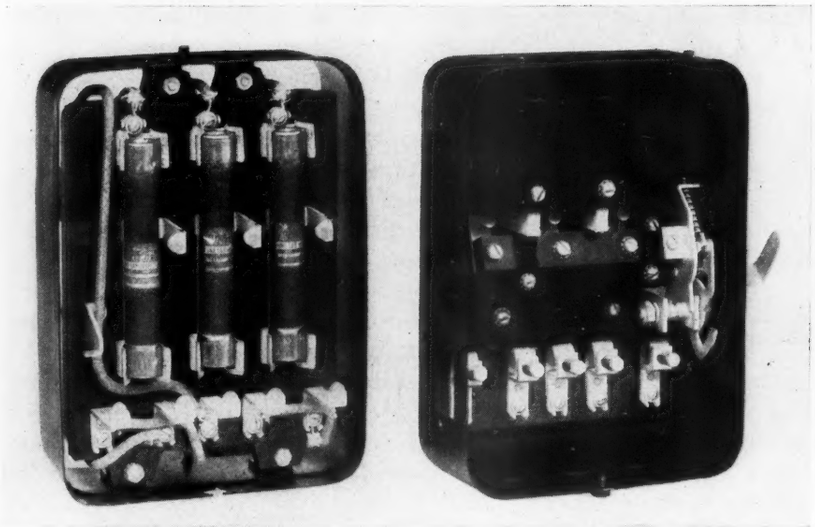

Fig. 3—Component parts of a magnetic switch equipped with fuses and a disconnecting element.

with a similar group of sizes of control devices. The motors may be of one, five, or ten horsepower or they may be one hundred times these sizes. Because of this wide range it will be best to divide the motors and their control into two groups for consideration of short-circuit protection. The first group will be the sizes involving currents up to 100 or 150 amp.; the second group will be the sizes above this figure.

To have adequate short-circuit protection, the devices used should interrupt the power before any of the interconnections or the devices are seriously impaired. Melting of some part of the circuit is the most common effect during a short-circuit. The rate of heating of these parts varies as the square of the current and directly as time. The quantity of current drawn cannot, in general, be regulated by the user, but he can regulate the time during which a short-circuit will flow.

A simple rule that can be remembered for determining how long a wire will carry very heavy current is as follows: "A copper conductor will carry for one second a current equal to one-tenth of its area in circular mils." It will carry a current equal to two-tenths of its area in circular mils for one-quarter of a second. For example, assume a wire of 0.1 in. (100 mils) in diameter or 10,000 circ. mil in area. One-tenth of this figure or 1000 amp. can be carried for one second. The temperature reached will be about 300 deg. C. but, where this occurs only infrequently and lasts for only a second, no harm is done.

But assume that a small starter has parts which are made of 10,000-circ. mil copper (0.1 in. diam.) and that this device is subjected to a short-circuit of 6,000 amp., which is a very probable value. It would be essential that this starter be disconnected from the line in 1/36th of a second. If the value is 10,000 amp. instead of 6,000 it would be essential that the starter be disconnected in 1/100th of a second. If these devices are protected by an ordinary type of circuit breaker or its equivalent, the minimum time that could be counted on for its opening would be a quarter of a second which is nine times too long for the 6,000-amp. short-circuit, and twenty-five times too long for the 10,000-amp. short-circuit.

From the foregoing arises the question, "What device will be fast enough and still be simple, inexpensive and dependable?" The only answer is a fuse. Fuses heat and function on the same basis as the conductors and devices and therefore the time required to function will vary with the amount of current. Fig. 1 shows the time-current curves of a group of fuses ranging from 65 to 120 amp. in size. Note that at a current value of 50 times normal, a fuse will interrupt the power in 1/100th of a second.

Answering the next question as to what size fuse should be used to give protection against excessive temperature during a short-circuit and yet not interfere during normal operation, Fig. 2 is used to show a combination of the time-current characteristic of a motor which will cause a 50 deg. C. rise, the time-current characteristic of a temperature overload relay for tripping, and the time-current characteristic of a fuse whose normal rating is four times the current rating of the motor. A long series of tests has proved that this ratio of 4 to 1 is the best average for the present.

It follows then that 100-amp. fuses should protect a 25-amp. motor and control under short-circuit and yet trip in time to protect all conducting parts from overheating. From Fig. 2 it should be noted that the fuse will never blow before the overload relay will trip when the current is eight times normal or less. This amount represents the stalled current of some induction motors. If the current is more than the stalled value then a fault exists and the current is almost certain to be many times its normal value. As shown, the fuse crosses the relay tripping characteristic at eleven times normal, which means that the fuse will interrupt the short-circuit before the parts reach a 50-deg. C. rise.

Cartridge type fuses are not made in sizes above 600 amp., which means that a 150-amp. motor and control are the largest with which they would be used. Therefore, when a control, 300 amp. or larger, is used, the parts should be large enough so that the control will either interrupt the short-circuit itself or will have sufficient thermal capacity to carry the current until some other switch opens.

Open Oxygen Cylinder Valves Carefully

WHEN putting the oxy-acetylene welding or cutting outfit into action, first release the pressure-adjusting handle on the oxygen regulator. The oxygen cylinder valve can then be opened. Barely crack the cylinder valve to let the high-pressure gage hand move up slowly until it comes to rest.

Do not open the valve so rapidly as to cause the gage hand to jump quickly. After a short time open the valve fully.

If oxygen cylinder valves are not opened carefully, damage to the regulator may result from the sudden impact of the compressed oxygen.

It is also advisable to open acetylene valves carefully although the standard acetylene pressure is much less than that of oxygen.

INDUSTRIAL ENGINEERING

L. C. MORROW, *Editor*

Vol. 88 APRIL, 1930 No. 4

A Look Ahead for Plant Engineering

PLANT engineers and maintenance men are more interested right now in how to organize their departments and their work than in any other phase of their activities. So they say in answering a questionnaire sent to them as readers of *Industrial Engineering*.

A healthy sign, this interest in organization. It indicates recognition of the function, with a wholesome desire to conduct the work along systematic lines.

Recognition of the importance of a function develops in two sources—the executive end of industry and the men to whom the function belongs. It may develop in one source before it does in the other, or in both at once. Finally, it must be possessed by both.

After recognition comes organization, the stage that we have now reached. Plant engineers and maintenance heads are intent upon deciding what shall be the details of the function, how the work shall be done, and by whom it shall be done.

After organization will come refinement, which may find itself expressed in many directions. Budgeting for plant upkeep, scheduled preventive maintenance, planned replacement and modernization of equipment, incentive wage payment or payment by results—these are some of the refinements to which we may look forward.

Is There a Good Belt Man in Your Organization?

OUR old adage, "Familiarity breeds contempt," contains a sound kernel of truth and helps to explain why little attention was paid for many years to mechanical power transmission equipment. This condition is still to be found in less progressive plants.

Belts, pulleys, lineshafts, bearings, and all such items have been in use for a great many years. There is nothing mysterious about them, and it is only natural for the feeling to have arisen that they need little care so long as they keep going. With it went the opinion that any handyman or jack-of-all-trades was perfectly competent to make repairs or give any attention required. That idea, too, is still far from dead.

It is true that bearings, for example, may need little care other than lubrication, and that lineshafts can get along with an occasional checking of the alignment. However, a great deal of trouble and expense have been caused by unwittingly putting belts in the same category.

Belts are subjected to much harder service and are more easily injured by abuse or neglect. The fact that fully 40 per cent of belting breakdowns are caused by carelessness or ignorance in joining is proof that too little attention is given to this operation, which is only one of several that must be properly done if maximum service is to be obtained.

The experience of many plants shows that it pays to put the belts in charge of a skilled workman who knows exactly how to join them, how, when, and with what to dress them, how to inspect them—in short, a man who can give the proper care from the time a new belt is put on until it is salvaged or junked. Assuming proper selection and application of the belts, a good belt man will make it possible for them to give the years of service that lie in them.

What Kind of Glass for the Plant?

THE kind of glass selected for the windows and roofs of the plant may affect the quality as well as the cost of the product. Illumination from the sun is ideal yet some conversion may be advisable. All sunlight that enters a building must pass through glass. Even slight variations in the type of glass will influence the results within the plant.

Does the floor area, on account of its extent, require diffused light? Or are the rooms so narrow as to permit direct light through clear glass? Are window shades to be used? How much dependence is to be placed on reflection? Are workmen to be able to see outside the building or not? Are people on the outside to be permitted to see in?

If ribbed, prism, hammered, or double-scored glass is to be used, what of shadows and glare? How will the type of glass selected take care of condensation? And how about maintenance? Is the glass easy to clean, and does it dirty quickly or slowly?

The problems outlined are part of those that must be considered if selection of glass is to be made in conformity with sound principles. They are of great importance when a new building is to be erected. Leading architects and designing engineers have studied the problems indicated and

possess many facts upon which to base their selection of glass. But the plant engineer who will represent the plant in dealing with the architect must know that the problems exist, and be ready to cooperate by giving complete information concerning the nature of his products and processes.

The same problems are also of great importance in building maintenance. When replacing glass in windows and roofs there is no absolute necessity to stick to the kind first selected. The whole character of daylight illumination in the plant may be changed by the substitution of one type of glass for another, even though the job is done piecemeal.

Knowledge of the objectives of daylight illumination; familiarity with types of glass and their characteristics; information concerning the plant products constitute one of the many vital problems of the plant engineer.

One Hundred Years of Weighing

THADDEUS FAIRBANKS, in 1830, invented the platform scale. Since then the civilized world has enjoyed 100 years' use of accurate weighing machines, based on the principles he established.

There is no industry, no occupation, no life, which the weighing scale does not enter into or affect.

Fulton, Franklin, Edison, and a hundred others are names whose owners are acclaimed as benefactors of the world because of their inventions. Fairbanks deserves a position along with them in the hall of fame.

Try Putting Your Job on Paper

TRY writing out a list of your duties. Then write the details of each duty. After that go through the same procedure for each man in your department.

When you are through you'll have a manual of operation of your department. From it you can draw an organization chart if one is needed. It will serve as answers to many recurring questions. It will be ammunition in your hand when you are asked to reduce the number of your personnel.

Possibly you'll be able to go right through with the job of writing a manual—no hesitancy, no errors. But the chances are that you'll scratch a lot of dandruff and ask a number of people quite a group of questions.

Every job that is of even a little more than ordinary importance deserves writing down. Why? Because, in the first place, it shows whether or not the owner of the job really knows it—when he does the writing. If the boss is the author it shows what he knows. And if a man quits, or gets fired, or is incapacitated, there's the story of his job all ready for his successor. In nine cases out of ten it will show that there is something wrong—inefficiency, waste, too little system, too much system—other things.

Sounds simple, is educational. Try it.

Worthy Institutions, These Electric Repair Shops

ELECTRIC motor repair shops are no insignificant part of our industrial layout. There are in the United States about 1,500 that are set up in their own establishments and have their own equipment.

What do they do? Repair and rebuild motors and other electrical equipment, sell new equipment, buy and sell used equipment, carry on contract inspection service in industrial plants.

Especially from the point of view of the smaller plant are they of value. The amount of equipment in the small plant does not justify keeping an electrical expert on the payroll. The local motor repair shop serves instead, being always ready with service and rental or new equipment.

Perhaps manufacturers of electrical equipment do not give the motor repair shops all the recognition they deserve. Some of these shops, with from ten to twenty men on the payroll, buy from $100,000 to $250,000 worth of equipment, parts, and materials per year. Moreover, they are in ideal positions to build good-will for manufacturers, to say nothing of actually selling their products.

The men of the electric motor repair shops are a splendid group. They are resourceful, take pride in pulling their customers through tight places, never let them down if hard work and ingenuity can keep them going. They have their shops on prominent streets, on dingy streets, on alleys, and in backyards. But they are practical men, have unbounded confidence, and genuine pride in their work. They are worth knowing and worth understanding.

You must have the history of a plant and know something about the wear and tear on the property and the equipment before you can intelligently approve a budget.—E. C. BRANDT.

MATERIALS HANDLING

ABSTRACTS of papers presented at the National Meeting, Materials Handling Division, American Society of Mechanical Engineers held in conjunction with the First National Management Congress, Chicago, March 3 to 7.

Western Electric Developments at Kearny, N. J.

By C. K. PEVEAR

Assistant Distribution Engineer
Telephone Sales Department
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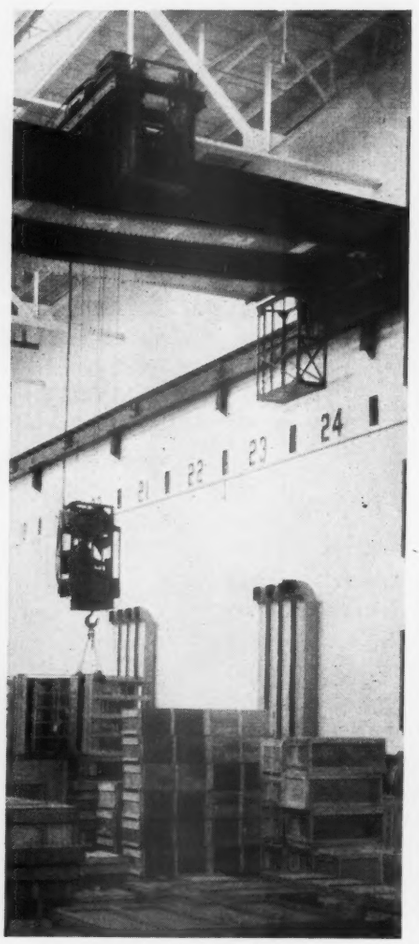
Kearny, N. J.

THIS description covers the Western Electric Company's merchandise buildings at Kearny, N. J., their purpose, and the methods used in materials handling in these buildings. A thorough study was made of the purpose of these buildings, the type of the material to be handled, and the possible future change that might be made in the amount of work to be done and the dimension of units handled. Then the warehouse activities were laid out, and a building was designed to inclose them. Approaching the problem in this manner provided unusual design opportunities that are not generally met in practice, as in most cases equipment has to be fitted into an existing building or into building space.

At the present time the Kearny manufacturing department is called upon to produce approximately 20,000 different items. Some of these items are piece parts, which, when assembled, make up the larger units. The Kearny merchandise department is required to stock approximately 9,000 items. These items vary in weight from less than an ounce to a ton; they vary in size from a piece as small as a pinhead to units 10 ft. long, 8 ft. high, and 6 ft. wide.

Handling of Material

At Hawthorne and at Kearny the buildings are so separated from the manufacturing buildings that automobile trucking is required. In each building material is brought down to the first floor and loaded on auto trucks at different loading platforms.



Crane area showing bay-numbering system. The crane cab shown is mounted directly above the hook and moves with it.

When these auto trucks are unloaded and received by the merchandise department, the material is divided into two classes—large bulky items, and small items.

Bulky Material—Bulky items are brought into the warehouse on the east end of the first floor of the multi-story building. These are, for the most part, on platforms and are deposited momentarily on the floor and very close to the doors leading from the automobile court. There is installed a tramrail hung from the ceiling, which has a floor-controlled electric hoist and the carrier pushed by hand. The larger and heavier material is handled entirely from the platforms to the storage conveyor by this tramrail.

At the end of the general packing line the conveyor turns at right-angles to the marking and scale section, and then goes through a large opening in the wall into the so-called crane shed, Building 72, where the majority of this large material is stored.

An odd type of crane is used in this building. The cab position is unusual, as it is mounted directly above the hook and, in fact, is a part of the hook, as the top of the shank above the ball race is a large plate with holes in it and becomes the bottom of the cab. The operator sits down and his feet rest on this plate, so that he can swing the hook and load by pushing the plate and at the same time look through the slots or over the edge of the floor and see the position of his load.

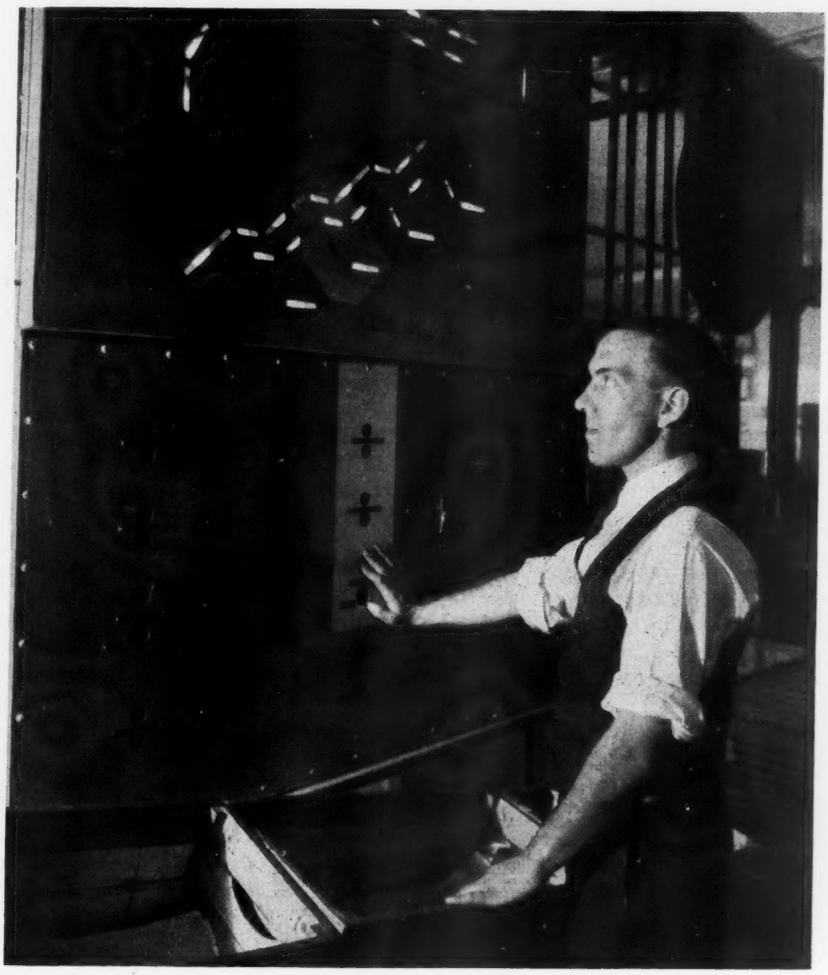
Complete control of the crane is maintained entirely within this cab and is accomplished by pilot circuits through relays. The hoisting speed is 150 f.p.m., which is necessary because a lift of 60 ft. must sometimes be made before the crane can travel in other directions.

It was necessary for the operator of this crane to be on the hook, for he must unfasten the tackle from the box and also attach it when loading. Floor men could not climb to the top of these piles as some are 35 ft. high, and many ladders, aisles, and men would be required, as the crane very seldom has two boxes going to the same bay in succession.

Small Material—The smaller material is sent over from the manufacturing department in containers which are approximately 24 in. long, 16½ in. wide, and 6 in. deep. These containers are usually placed on platforms or on shelf trucks.

All orders received by mail from the distributing houses are edited, typed, and sent out for either immediate selection or manufacture. Those for selection are sent to the warehouse, where they are sorted for location of material and sorted so as to get like addresses together and stencils cut for all shipping orders.

Live-roller drive on a conveyor making a 90-deg. curve.



Dispatcher's position at the signal and control panel.

Dispatcher's Position—Orders are sent by pneumatic tube to the dispatcher. His position on the second floor is the heart of the entire system. There is a large signal board in front of the dispatcher's position which is laid out to look like a bird's-eye view of the critical points of the conveyor system, and by a number of different colored electric lights in the slots, the dispatcher can see whether the distant belts are running, what position the switches are in, and how many and where the boxes are that he is sending out.

Just below this signal board are banks of electrical pushbuttons controlling remotely all the belts and switches which the board pictures in miniature, so that the dispatcher has a visual check on the result of his manipulation of the switches.

There is also at the dispatcher's position a microphone and the various controls of an extensive public

address system, by which he can transmit information concerning incoming material to the storage floors above and concerning outgoing material to the car-loading positions or the shipping platform.

Live Roller Curve—It was necessary to develop a new type of live roller curve which could have its rolls adjusted as to lead, so that the carriers would remain parallel with the conveyor after rounding four curves. This function was accomplished by using the live-roller principle and a 2-in. belt and snubbing down every 2 ft., so that the belt could take an eighth-turn and change direction almost like a rope drive; then slotting the inside frame lengthwise, and by using a clip on the shaft end, the lead can be adjusted within limits.

Gate Sections—The gate sections could not be made of gravity rolls as it is essential that the carriers do not catch up on one another. A belt section was developed which is driven from the live-roller section preceding it and which can be raised without shutting off the motor.

Automatic Switch—The automatic switch is controlled by the carrier as described. Just ahead of the switch there are two "hot" rolls connected to opposite sides of a 110-volt control circuit.

When the carrier passes over them with a plug in the jack, the circuit is completed, and the motor-driven alligator switch responds if it is in the right-hand position and shifts to the left. If it is already in the right-hand position, it stays there. The box, not having means of completing the circuit, throws the switch to the right-hand side or compels it to remain fixed.

Mixed lots of boxes and carriers can pass this point and throw the switch back and forth if they are 3 ft. apart. The selectors are instructed to allow 5-ft. headway.

"Y" Section—The conveyor line from the floor above joining the loop on the floor below makes a "Y" section necessary, and if not automatically controlled, would have been a source of trouble. A 4-ft. feeder belt was placed in the gravity roller preceding the "Y" section and a floating roll in the down-coming line, so that when a carrier is coming down and depresses the floating roll, it shuts off the motor operating the feeder belt and starts a timed relay, giving the carrier a chance to get on to the loop before the main-line feeder belt is started up again.

Sorting and Packing—Packing boxes going into a car to some distributing house take a sorting line, and the dispatcher directs their course of travel through the remote control of the switches. Only one car is loaded at a time, and this is done by a belt used as a "lowerator," which is lowered by the dispatcher from his position by means of push-button control, and is recorded on his signal panel by means of lights.

This lowerator delivers the boxes opposite the car door, and when a portable curve section is attached, the boxes run into the car. When the lowerator goes down, its downward movement throws a deflector across the live roller line feeding it, but the actual movement of the belt on the surface of the lowerator is controlled by a floor-operated clutch, which is in the control of the loading gang.

In place of bridges across the railroad tracks, small flat cars, 12 ft. by 11 ft. 6 in. with roller bearings, have been installed. These cars have rings on the four corners and can be lifted out of the way by the crane when cars are shifted; can be rolled along the track to affect convenient crossing points, and can be used to move small loads of material to the dock for water shipment.

Designing for Safety in Materials Handling

By R. H. HUCKE

General Electric Company, Schenectady, New York

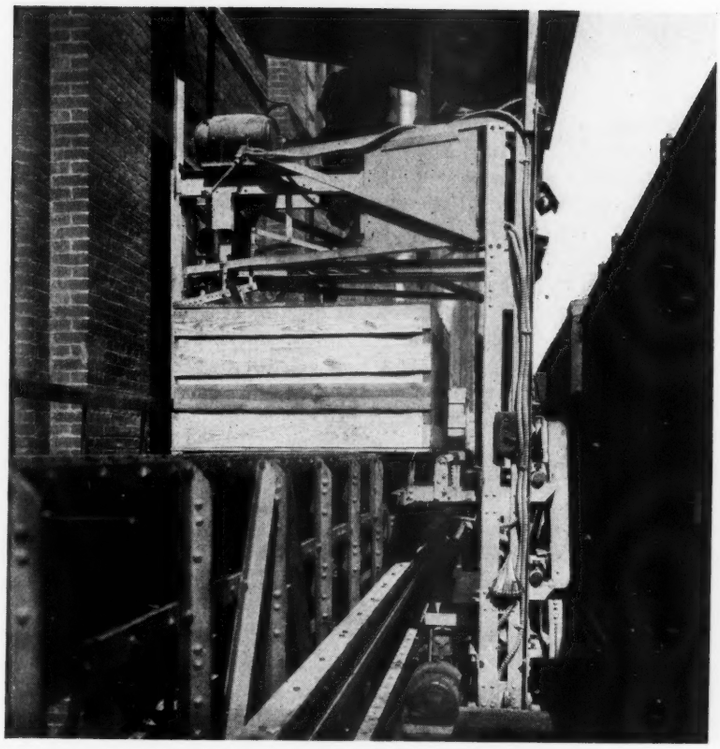
REFRIGERATOR box manufacture requires a large tonnage of steel which is fabricated into shape, after which it is prepared for painting and enameling. As soon as it is finished, ready for painting, it is suspended from an overhead chain which carries it through the several finishing operations, through the ovens, and directly to the assembly floor.

The assembly is organized in a continuous straight line on a moving apron conveyor to a point where it is ready for shipping. At this point another conveyor takes the packing cases from the carpenter shop to the assembly line, where the units are completed and made ready for shipment. At this point the boxes are dropped into the packing cases and carried to the shipping platform by means of a conveyor. These units vary in weight from 400 to 1,100 pounds.

As each size cabinet is of a different width, and all cabinets must be diverted from the power roller chain conveyor approximately at the center of the unloader, a special electric switch was designed, called the selector. This selector consists of several contacts, one for each size of cabinet. Each of these contacts is connected to a limit switch, which is mounted on the unloader frame and set to start the transfer arm at the proper time for each size cabinet.

An arm on the unloader is used to transfer the cabinet from the power roller chain conveyor to the tilting mechanism. This is accomplished in the following manner: The cabinet, still on the power roller chain conveyor with its feet pointing toward the freight car, enters the unloader and engages the transfer arm. This automatically sets the contact, or selects the limit switch which is to divert the case. When the case has thus set the selector and depressed the proper limit switch, the transfer arm motor starts and, in turn, through a crank and lever movement, diverts the cabinet from the power roller chain conveyor to the tilting mechanism.

When the transfer arm has reached the end of its outward stroke, it closes a limit switch, which starts the motor operating the tilting mechanism table on its downward movement. This movement is through a worm reducer, pinion and gear segments, which causes the table to move



Side view of unloader showing crate in transit.

through an arc of approximately 90 deg. The cabinet is lowered to the freight-car floor on its feet and is manually removed from the tilting mechanism table and trucked to its position in the car.

For safety, the tilting mechanism does not return to its loading position automatically, but by the operator pushing a starting button. A complete set of emergency buttons is also provided so that the unloader can be controlled through them temporarily, in the event of failure of a limit switch.

At the Schenectady Works the following procedure is in practice in the selection and use of materials-handling equipment: To help insure safety, all layouts involving the use of conveyors are submitted to the works safety engineer for inspection. A thorough check, from a safety standpoint, is thus given each layout. No conveyor is permitted to be installed until the works safety engineer is satisfied that it will be safe. After the conveyors are installed, another inspection is given them to further the cause of safety before they are put into final operation.

Only designated employees are permitted to operate the conveyors, and they are instructed at all times to play safe in their work. Accidents result in a loss of time and money to both the injured employee and the company because the amount of compensation received cannot equal the worker's regular earnings, and the cost of compensation represents an expense that must be added to the business. The work of properly promoting the interests of safety is important, and the company realizes that it pays to give considerable attention to this item.

What Does the Materials-Handling Equipment Manufacturer Need to Know to Make a Successful Installation?

By N. H. PREBLE

Vice-President and Chief Engineer
Mechanical Handling Systems, Inc.
Detroit, Michigan

IN general, the following conditions must be examined: (1) Purpose of proposed handling installation. (2) Nature, weight, size, etc., of material or articles to be handled. (3) Capacity required. (4) The path which the material must follow. (5) Details of building or space within which the equipment is to be used. (6) General information as to power available; unusual conditions of temperature, moisture, etc.; erection conditions; and the like.

In many large corporations the plant engineering department will include a division or group specifically charged with the solution of handling problems. This group may have sufficient knowledge and experience to select equipment, arrange all details of its design and installation and issue complete specifications and drawings, all without reference to or advice from the manufacturer.

In most plants, however, no such complete drawings and specifications can be made up, as the engineering department is not properly equipped to do this type of work. This type of user may perhaps not even recognize that a handling problem exists.

Let us divide handling equipment into classes according to purpose. We find in general, three main divisions:

1. Transportation. Where the purpose is merely to move material from one point to another, vertically, horizontally, or on an incline.

2. Assembly. Where an article is carried, continuously or intermittently, from one work station to another, various parts being added or operations performed while in transit,

the article usually remaining on the equipment throughout.

3. Processing. Where some process is performed such as painting, drying, baking, heat-treating, or the like.

The combination of any two or all three divisions will occasionally be required.

In the transportation of packages, using that term as distinct from bulk material, the truck or trailer will, in general, be selected, if the path to be traveled is to vary and is to cover a large area. If however, the area is limited, certain conditions may make a crane more suitable, while if the path is fixed a conveyor will frequently be the final selection.

Where assembly operations are involved, a carefully detailed operation sheet must be made out, covering all operations to be performed, together with a time study of each operation. It will also be necessary to examine the means for bringing the stock to the assembly line and the storage space required for such stock alongside of the line.

Under the classification of processing, the time element must be carefully determined and stated, also all possible information as to the details of the process, the temperatures involved, any special conditions as to high moisture content of the air surrounding the equipment, acid fumes, and the like must be given.

Having determined the purpose, turn to an examination of the material to be handled. For bulk material, consider its nature, weight, and condition. Weight should be expressed in pounds per cu. ft., with a further statement in some cases as to whether this is dry weight or total weight, including the actual entrained moisture.

If the material to be handled is an article or package, full dimensions and weights of each piece should be furnished.

The question of capacity desired is next. For bulk material a simple statement as to the tonnage required to be moved per hour may be sufficient.

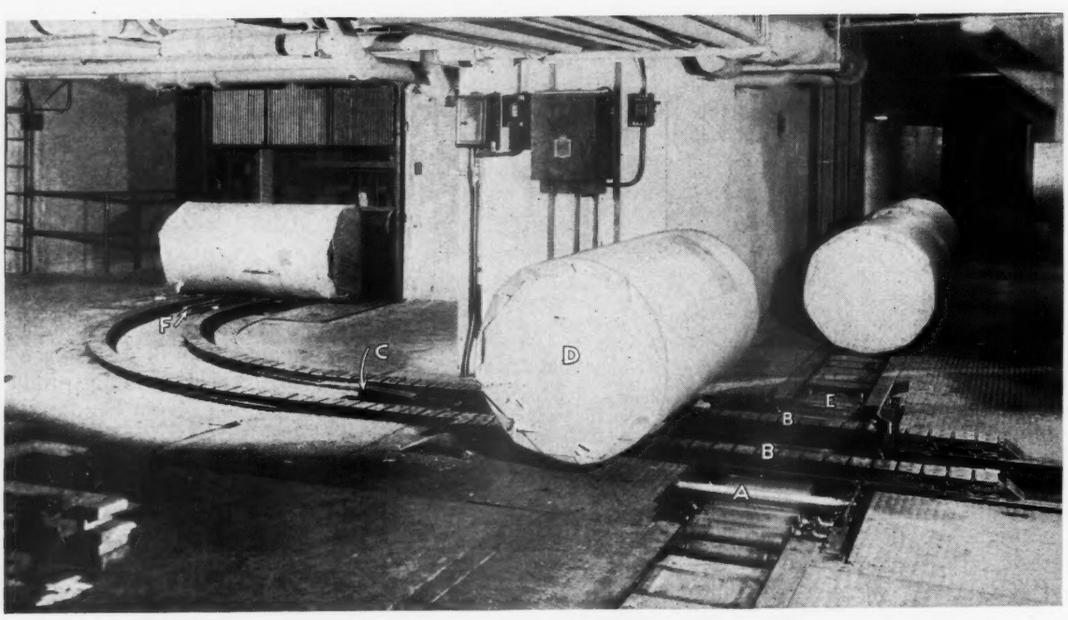
If the volume or tonnage varies greatly from time to time, maximum and minimum should be noted, and if the equipment is to be used only intermittently, the length of time within which it is desired to move a given quantity must be stated. These conditions affect the size of the equipment to be installed and its driving mechanism.

For transportation of articles or packages the capacity will be determined by the number of pieces of each kind or size which must be moved in a given length of time. One should also know whether they are moved to an assembly operation or conveyor requiring synchronized speed and the sequence or rotation of the various parts properly to feed such a line.

For the assembly or processing operation, this information should be further amplified by details of how closely the articles may be spaced, that is, the maximum room required around the article for the operations involved.

Next, examine the path or paths through which the material must be moved. The best way to answer this question is by means of a layout sketch or drawing.

Building conditions may influence the choice; building information must include all details of the obstructions, such as location of steam pipes, sprinklers, light fixtures, conduits, ducts, and the like, which cannot be removed. Type of floor construction should be noted, and if any equipment may be hung from building steel, detail of that steelwork should be shown, with notations as to whether it may be drilled for an attachment of hangers or other structure. In concrete buildings, thickness of the floor should be shown, together with the type and location of ceiling inserts if any exist. Where openings are to be cut through the floors or walls, it should be definitely understood whether the user contemplates doing this work, together with the patching and housing of any such openings himself, or expects it to be done by the equipment manufacturer.



A close-up of the method of transferring paper rolls in the Chicago Daily News plant from an apron conveyor to a cross-lifting conveyor via two strand chain conveyors which carry the roll around a 90-deg. curve. When the roll comes in contact with the cross bar A, the live roller conveyor is stopped. The lifting mechanism of the two strand chain conveyors, marked B, automatically passes the roll D onto the chain conveyors making the turn. Letters C, E and F indicate automatic stops.

Coordination of Handling Equipment in the Pork Packing Industry

By A. W. DeVOUT
Engineer
Swift and Company
Union Stock Yards
Chicago, Ill.

IN contrast to the automotive industry where many raw materials are assembled for the manufacture of one variety of product, the meat packer dismembers one raw material, live stock, to produce many varieties of goods.

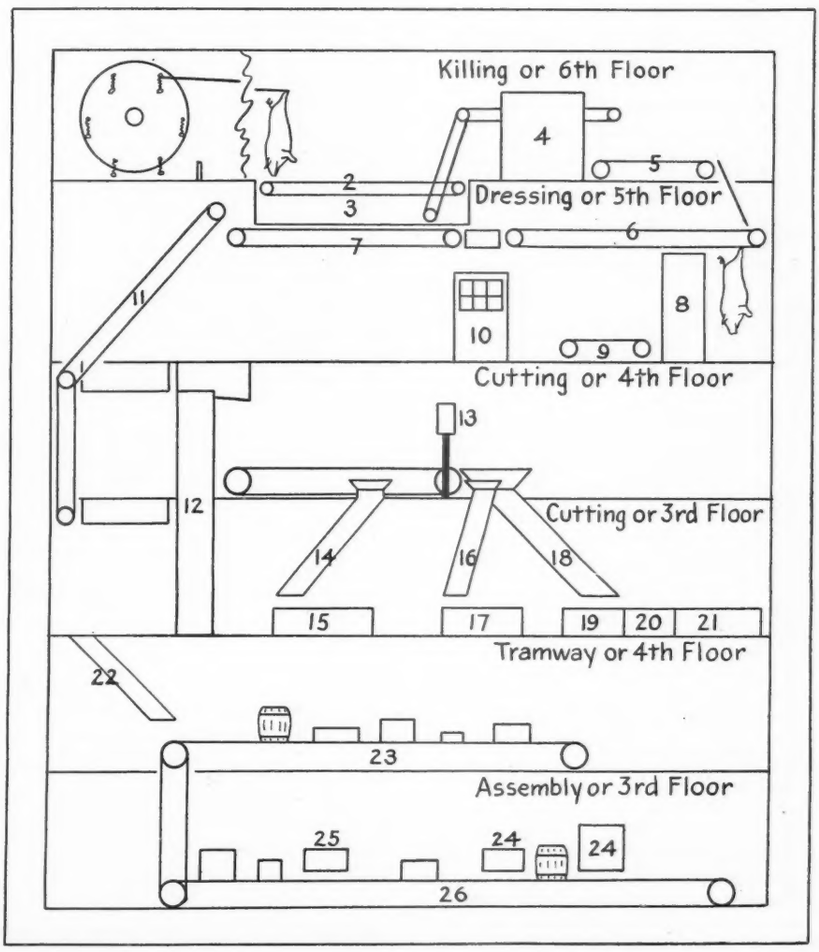
These two differing types of industry, however, use practically the same handling equipment, perhaps slightly altered to fit particular needs. In the packing industry, a pioneer in applying mass production to a continuous-line operation, the equipment has been so adapted, and so coordinated with the rest of the plant, that an almost continuous flow of material is maintained from the buying pens to the shipping docks.

Although but one of the many departments, the pork department offers the best illustration of co-ordination among the various types of handling equipment indicative of the industry. This flow of materials is illustrated by means of the accompanying diagrammatic sketch.

It will be seen that the assembly conveyor on the third floor cooler level receives fresh packed pork orders and smoked meat packed orders through chutes. This conveyor, which is of the slat type, is connected by a gravity roller conveyor to another, a slat conveyor also, which raises the packed goods to the tramway conveyor.

Backed up against a rail which runs parallel to the shipping or tramway conveyor is a row of tractor trailers. In an aisle between this rail and the conveyor, the shippers stand removing from the conveyor the goods destined for their particular cars. Each man has assigned to him certain cars, and as each address on the package is marked with the car number, his work is quite simple. On this tramway the tractor trains are made up, and the tractors, now loaded, haul the product via the overhead tramways to a tractor train elevator which drops the entire train to a loading dock.

Other departments are equipped with similar assembly rooms that are tied in with the tramway system. With the use of different assembly rooms in the various buildings, the overhead tramways, and five tractor-train elevators, only a short space of time elapses before an order including items from many departments can be placed at the door of a refrigerator car.



DIAGRAMMATIC SKETCH OF HOG HOUSE

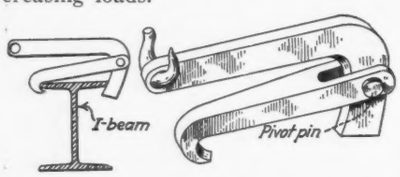
1. Shackle wheel
2. Scalding vat conveyor
3. Scalding vat
4. Dehairing machine
5. Gambrelling table
6. First hog dressing chain
7. Second hog dressing chain
8. Automatic singer
9. Viscera inspection table
10. Scale house
11. Cooler conveyors
12. Lift to bring hogs to cutting room
13. Shoulder chopper
14. Ham chute
15. Ham dressing table
16. Shoulder chute
17. Shoulder dressing table
18. Side chute
19. Loin table
20. Side and rib table
21. Belly trimming table
22. Sliced bacon table
23. Shipping conveyor
24. Fresh pork chutes
25. Smoked meat chute
26. Assembly conveyor

AROUND *the* WORKS

THIS SECTION is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.

Crane Hook That Increases Safety in Handling Loads

THE practice of using loose wire slings for handling large parts with a crane caused several accidents in one shop. In order to prevent these mishaps, the shop foreman devised the supplemental crane hook shown in the illustration. The main feature of this hook is that the grip tightens with increasing loads.



With this hook the grip increases with the load.

The hook consists essentially of two pieces of forged steel. One part is formed as a hook, whereas the other is an L-shaped part, pivoted to the hook. In the end of this part is an eye for the crane hook.

Various sizes of these supplemental hooks are provided for handling the variety of work that has to be transported about the shop. Structural work and castings can be handled with equal facility. G. A. LUERS.
Washington, D. C.

Let Service Dictate Lubrication of Cables

AN important service of cables is found in connection with elevators. There are also hoist and crane applications; however, the elevator is used exclusively to carry human freight and close attention must be given to the condition of the cables at all times. In one plant it was observed that the cables on a traction-type elevator never had a visit from the grease pot, and as a result there was considerable wear between the wires.

On another elevator in the same plant the cables were noticed to be literally covered with grease. Even so, the drums showed considerable wear. This latter case, it developed, was quite accidental. A piece of sheet metal on the pent house floor caught the drippings from the hoisting mechanism and allowed the oil to run down the cables. It was quite evident that lubrication of cables was a dead issue in this plant.

Further observation disclosed several air hoists in operation in the foundry, from which the exhaust discharged water on the drums and the wire cables. A sheet-metal baffle had been constructed in front of the exhaust, but bent back in such a manner as to direct the moisture against the drum. The shield was serving its purpose of preventing the moisture from being sprayed into the air and causing a misty atmosphere in the vicinity, but it was ruining the hoist cables.

It is evident that the result of excessive lubrication or the lack of lubrication will be inflated maintenance cost, and to reduce this expense on this type of equipment some standard of lubrication must be established. There should be just enough lubricant frequently applied to keep the cable in a pliable condition.

Examples of service from well-maintained cables constitutes a reliable guide. On a machine giving twenty-four hour service an application of the proper lubricant by means of a brush every three months will keep the cable in good condition. In general, it is best to make the applications more frequent and use less lubricant than to err on the side of too much grease.

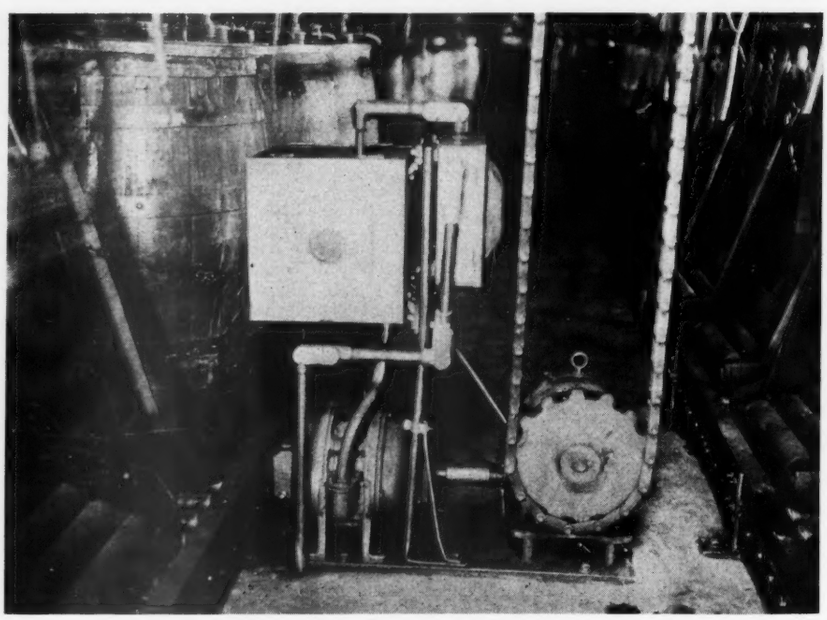
Lubrication of other types of cables in the plant depends somewhat on the service rendered or expected. A cable which must work out in the weather naturally should be lubricated oftener than one working under shelter. For example, a cable on a locomotive crane working out in the open is lubricated weekly whereas one on a traveling crane working under shelter is lubricated once a month. Both cables have been in service a long period and are in good condition. H. C. CHARLES.
Waterloo, Iowa.

Power Lift Does Away with Back-Breaking Effort

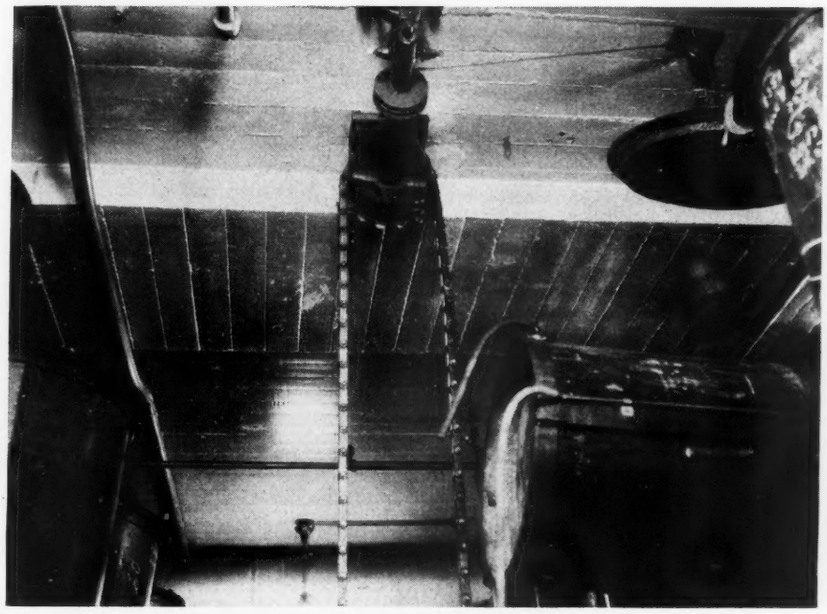
AN example is portrayed by means of the accompanying illustrations of how a highly-mechanized plant is equipped to lighten the burden of attendant employees. The plant is engaged in the manufacture of pharmaceutical products, some of which in the course of production are handled in containers of the types shown.

In order to conserve space and to obtain the advantage of straight-flow production, these containers were mounted in two tiers, one above the other, on a double-decked conveyor.

When the material contained has percolated sufficiently, the containers, weighing several hundred pounds, must be emptied of their contents, an opera-



Drive end of percolator power lift.



Upper element of percolator power lift. Two operations are done simultaneously.

tion formerly accomplished by man power. The containers are swung in a saddle perpendicular to the line of movement of the conveyor.

In keeping with the balance of the equipment the device shown was devised to do away with the back-breaking effort required for the dumping operation. It consists of a motor-driven worm gear driving a section of roller chain between two sprockets, the control of which is manipulated from the unloading platform. The upper sprocket is suspended from the ceiling on a shaft containing a small drum of a specified diameter.

By referring to the illustration above it will be noted that two operations are performed by the power lift. The lid is carried upward and out of the way at the same time that the percolator is being tilted. The pulley diameter is such that the lid clears the outer rim and approaches its limit of travel as the percolator is brought to a position slightly above the horizontal, as shown.

Each percolator is equipped with a link in the bottom rim to enable the operator to attach the short piece of chain making the connection between the vertical roller chain and the percolator when it is in a vertical position.

Lowering the percolator is simply a matter of reversing the motor.

Indianapolis, Ind. J. C. SIEGESMUND.

Inexpensive Signal to Show the Proper Operation of Motors

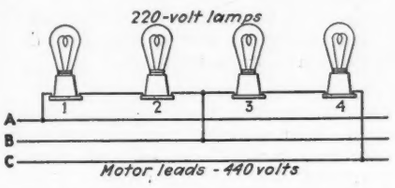
OFTENTIMES it is necessary, through lack of space or to make driving conditions better, to mount motors on platforms several feet above the floor. In such cases inspection may be very inconvenient and, therefore, neglected.

Motors operating from a three-phase system are subject to running single phase, owing to the blowing of a line fuse, and if the condition is not detected the motor windings will heat up dangerously and may burn out.

On some installations, feeders from distribution boxes or panels are protected by fuses, but individual motors may be protected by a circuit breaker, allowing the same condition to exist should a main feeder fuse be blown while the motors are in operation.

A simple protective device against the above conditions can be made from four porcelain lamp receptacles fastened to a board; or a much neater job can be made by using conduit fittings, placing two such fittings, with lamp receptacles, on each side of a tee fitting. As shown in the diagram, the lamps are connected in series, bringing out a lead from both ends and one from the middle, thus giving the three leads to be connected across the three motor leads.

Connect the lead from lamp *1* to motor lead *A*, the center lead to motor lead *B*, and the lead from lamp *4* to motor lead *C*. It will be seen that on a 440-volt circuit, using 220-volt lamps, when the fuses are all good the lamps will burn brightly at full voltage.



Four lamps connected as shown will indicate a blown fuse on any phase.

Should the fuse protecting motor lead *A* be blown, lamps *1* and *2* will be out, whereas lamps *3* and *4* will still burn brightly. With a blown fuse in motor lead *C*, lamps *3* and *4* will be out and lamps *1* and *2* will burn brightly. Thus, this device not only indicates trouble, but tells which fuse is blown.

The lamps may be located at any convenient place where they can easily be seen, and operators may be instructed to watch for signs of trouble. If this device is operated on a three-phase, 220-volt system, use 110-volt lamps. N. H. CASE.

Chief Electrician
Wyckoff Drawn Steel Company
Ambridge, Pa.

Eliminating Noise in Machinery

SOMETIMES the vibration of machinery causes much undesirable noise and distress, and the question is asked: "How can we stop this vibration?"

One concern of my acquaintance decided that the best thing to do was to lay a heavy foundation under the machine—so heavy that the comparatively small machine would be unable to cause the heavy mass to vibrate with the machine. This machine was on a second floor. The heavy foundation installed was made of lead. The method "worked" but there are two objections to that method. First, it is expensive. Second, it is sometimes impossible to increase the load on a second floor without adding reinforcing columns underneath.

The best method I know of for eliminating vibrations of this sort is the use of cork board. By using cork, vibrations may be eliminated "scientifically." Do not distribute the weight over a large area of cork, however. The area must be restricted so that the cork will be under the right amount of compression. Sometimes cork of different densities is used. Sometimes heavy concrete foundations are poured directly on top of cork board, and the sides of the foundation are lined with cork of proper thickness and density.

Newark, N. J. W. F. SCHAPHORST.

Hard Soldering Rotors with a Low-Temperature Flame

ONE of the most important details in motor repair work is the correct brazing of rotors. In most cases a rotor which has been improperly brazed will perform its duty when replaced on the job, although the characteristics of the motor are no longer as the maker intended. Later, when trouble develops the conclusion is that the machine is of an inferior make.

In examining many rotors which had been brazed previously, one wonders from the condition as found that satisfactory operation was possible. Often a squirrel-cage rotor, with say, 4 thin end rings on each end, has been com-

pletely filled with bronze, reducing tremendously the resistance of this important section of the secondary circuit.

It is difficult to explain to a welder, who has had little or no electrical training, the importance of no excess metal and other details to be considered in rotor work.

It has been my experience that no matter how proficient a welding mechanic may be at his regular work, it is seldom that a satisfactory job, from an electrical standpoint, results. Occasionally welders who have had previous electrical experience specialize on rotor work and usually produce a satisfactory job. But they are not always available. This problem has been solved by hard soldering, which the maintenance man can readily do himself. No equipment is required other than a gas and an air flame, or a good blow torch. Although the system is fast and thorough, no particular skill is necessary. The alloys listed in the following table have proved excellent for this work. No. 1 fuses at the highest temperature, No. 6 at the lowest.

To illustrate the method one recent repair job will be described. A 28-in. rotor having 173 bars, ⅛x½ in., and 4 end rings on each end spaced about ⅜ in. apart was stood on end vertically. Each bar was to be soldered

PARTS BY WEIGHT

Silver	Copper	Brass	Zinc
4	—	3	—
2	—	1	—
19	1	10	14
57	28.5	—	14.5
66.5	23.5	—	10
66.5	25.5	—	11

at 8 points of contact, that is, to 4 rings at each end or a total of 1,384 joints to be soldered. The time required to complete the work was 2 hr. preparing the job, and ½ hr. with the flame. The alloy used was in the form of about No. 18 B&S gage wire. About 700 turns were wound on a ⅛x1-in. rectangular steel bar, clamped at both edges, and the turns then cut lengthwise along the center on both sides. Thus, about 1,400 pieces of brazing material in the shape of a U, ½ in. long, were formed. After standing the rotor on end the U pieces were placed around the bars on the top side of the rings at each point of contact and the job was ready for fluxing.

The best method of fluxing was found in mixing the flux with water to a thin paste and applying with a 1-in. brush over the entire work before heating. Borax proved good, also boracic acid. It appeared that a little better finished appearance was gained by melting together equal parts of borax and washing potash, which mixture was ground fine after cooling. Next, the heat was applied and this seemed the only part of the process that required a little caution. A 1-in. gas and compressed-air torch produced the best results, but dexterity was necessary in adjusting the blast and manipulating the flame so that the temperature was neither too high nor too low. Heating about 6 in. of the surface or about 6 bars at once to a dull cherry red, applying extra flux when needed (in dry form, but no extra alloy), and progressing steadily around the work as fusion took place, completed the soldering.

The result was a small bead of alloy evenly fused around the bar and to the ring, top and bottom. The opening was completely filled; the alloy having run through, and an equal but not excessive amount of solding material on each of the 1,384 joints.

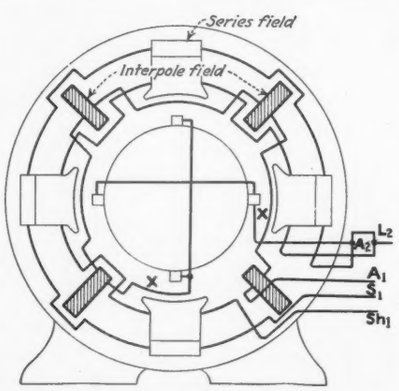
At first it may appear that the use of an alloy carrying a large percentage of costly silver would be prohibitive, but when it is realized that the job mentioned consumed only 11 oz. of material this objection is not serious. Also the solder fuses to the work so readily that it has been seldom necessary to resolder a single joint after inspection.

W. O. HURLBURT.
San Francisco, Calif.

Reversed Interpoles Cause of Trouble with Compound Motor

AN interesting case of trouble developed recently in a 35-hp., 230-volt d.c. compound motor having interpole fields. This motor had not been in service for several years, but an insulation resistance test showed the insulation to be in good condition.

Upon starting up the motor nothing unusual was observed until it was nearly up to full speed. The brushes then sparked severely and finally flashed across, blowing the fuses. The motor had interpole fields, as shown in the illustration. The wiring was checked up and found to be correct. The direction of rotation of the machine was the same when operated as a straight shunt motor (with series field open) as it did when started as a series motor (shunt field open). This check showed that it was not connected up differentially.



Reversing leads marked X changed the polarity of the interpoles and restored normal operation.

Eventually one of the older men in the plant remembered that when previously used, the motor had been mounted on a wall, and had been obtained from the manufacturer with the endbells turned 90 deg. from the normal position. As the brush-holder studs were fastened to the endbells, the change to the normal position moved the brushes 90 deg., reversing the flow of current through the armature. As the polarity of the interpole fields was not changed, their polarity was wrong for the new condition.

By reversing the two leads marked *X*, conditions were brought back to normal and the motor function perfectly thereafter.

Chief Electrician, CHAS. A. PETERSON.
Cold Spring Granite Company,
Cold Spring, Minn.

Wire Changes Correct Reflector Trouble

UNLESS close attention is paid to the selection and installation of flexible suspensions for light reflectors some difficulty will be encountered with their operation.

In one plant swivel-base sockets were used throughout. Heating of the plant was by means of unit heaters hung well up in the ceiling. These heaters, owing to their fans, exerted a force against the reflectors causing them to swing gently back and forth. In a short time the insulation on the wires within the swivel sockets wore away and short circuits resulted. From that time on the electrical department was kept on the jump repairing the lighting system.

Swivel-base reflectors were adopted as standard devices in another plant and all new installations incorporated this type of base. The buildings were of the monitor type, with the lamps mounted high enough to clear cranes and other overhead work. With the plant in operation the reflectors swayed slightly all the time. In this case the insulation on the wires wore out and short circuits resulted.

In both cases investigation disclosed that No. 12 wire was used through the sockets.

Thereafter trouble from short circuits was eliminated by replacing this wire with No. 14 rubber-covered wire in one case, and in the other, with No. 12 stranded wire. This No. 14 wire was the ordinary, single rubber-covered variety. The clearance within the socket was ample for this wire to change position with the swing of the reflector without rubbing on the edge of the connection, whereas with the No. 12 stiff wire nearly all this space was taken up and each time the reflector moved the wire came in direct contact with the connection.

It is not common for insulation to wear and fray on the wires, but this detail was just overlooked. After making these corrections no further trouble was experienced.

H. C. C.
Waterloo, Iowa.

PLANT · ENGINEERS' · FORUM

* * *

Here is the ninth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

* * *

Is It Better for Maintenance or Production Department to Control the Operation of Cranes, Elevators, and Trucks?

Our last contact with George Shipman and Frank Fulleger occurred while they were driving to a plant about 100 miles distant from their town. Now we find them making the return trip—and of course they are talking.

* * * *

"A mighty good visit, George. Glad you asked me along. Guess I got enough stuff to think about for a couple of months. A progressive plant engineer they have there—don't you think?"

"Yes, I do, Frank. Bill is always on his toes. Notice what he said about cranes being altogether in charge of the maintenance department?"

"Did I? That's one thing I've been trying to get across at our place. I've got all trucks in the hands of the maintenance crew now. Sold that idea because many of them are storage battery trucks and if the batteries won't bat the trucks won't truck. That makes the electrical maintenance man most important so far as they are concerned. It was only a step from there to have all trucks, electric and otherwise, put into the same category."

"Bill figured the thing about the same way, I think," said George. "But he went two steps farther—took cranes and elevators under his wing. As he explained it to me, he figured that because the going power is electricity, and his men have to keep them going, somebody from the same department should be in position to see and to say how they are used."

"The way he told me, George, he's even worked out some schedules, so that cranes, trucks, and elevators don't travel empty much of the time."

"It isn't so much a schedule, Frank, as it is a system. Got his men to see that it was wasteful to travel empty—and they systematically look for loads before starting any place."

"Wish I had it that way at my place," said Frank. "I believe I see how I could save some money. As things are now, the production department operates the moving equipment, but I have to keep it ready for operation. They wear it out—I build it up. Doesn't seem to be any justice in that."

"I've worked under both arrangements, Frank—and I have my pick. Won't tell you which it is, but want to remind you that you didn't hear the production side of the argument today. Remember that cables are mighty important parts of cranes and elevators. How good is the electrical crew when it comes to dealing with cables?"

"Be a good thing, George, if we could get the opinions of a lot of plant men, wouldn't it?—electrical and mechanical—and have them give us both sides of the story?"

"Sure would. By the way, we'd better eat here. Never make it home in time for dinner. What'll it be—steak and onions, or ham and—?"

* * * *

And now let's give Frank and George both sides of the story.

Should the maintenance department have charge of the operation of cranes, trucks, and elevators, as well as their maintenance? Or should the production department have charge of operation? Is there any other arrangement that will work out better than either of the two suggested?

Let the editor have your discussion within the next three weeks.

(Answers to previous questions start on the following page)

READERS' ANSWERS

to previous questions

How Develop Key Men for Maintenance Work?

(Question Presented in the March Issue)

DEVELOPING a key man, or specialist, for any particular plant department or function seems to me to be a task best accomplished by picking the man from the ranks of the best workmen. Failing to find suitable material there, only one alternative is left, that of hiring from the outside or training on the inside.

In any plant needing key men there can be found some who have the leaning toward the particular job to be filled. These can be taken and given a sort of post-graduate course which would consist of putting the individual on the job he is to hold and then giving him everything that will aid him to master it. His specific tasks must be outlined and his position made clear to him and to all with whom he is to come in contact. He must be given all the technical help available, especially publications and books. Let him sit in on any shop executives' conferences having any bearing on his part of the work. If his is to be a special task, send him on visits to plants having jobs similar to his. He must be allowed time and expenses.

About the only other way to get a man to cover the job is by hiring one all fitted who has been developed at someone else's expense.

CHAS. H. WILLEY, *Assistant Plant Superintendent*
Hoyt Electrical Instrument Works
Penacook, N. H.

How Shall Equipment Be Purchased?

(Question Presented in the February Issue)

EQUIPMENT is usually wanted by one of the production departments. In our case the heads of these departments are technical men who have well defined ideas and knowledge about their equipment, most of which is special. They specify what it is to be and, having conferred with manufacturers, from whom to purchase. They then give all this information to the plant engineer who has charge of all equipment installations. He prepares an estimate covering the job complete; namely, the cost of major machine or special equipment, motors, drives, piping and installation. He also decides how much of the auxiliary equipment is to be furnished by the manufacturers, such as motors, drives, hoppers, steel work, etc. This depends upon how much our own mechanical force is capable of handling. Often all the foregoing points are discussed in conferences by the plant manager, department superintendent, and plant engineer before action is taken or an appropriation is made.

We made many mistakes before this method was evolved. The following is a good example: A department superintendent would authorize and have purchased a certain machine to accomplish some necessary work, frequently second hand and apparently at a good price. Then it turned out to be obsolete in design, spare parts were special, a motor had to be purchased and connected, even gear guards had to be made. When finished it had cost as much and sometimes more than new and up-to-date equipment.

A. K. NELSON, *Supt. Mechanical Department*
Bakelite Corporation, Chicago, Ill.

THE purchase of equipment concerns more than one person. Buying of standard and staple products should be handled in routine by the purchasing agent. Other products, or equipment, intricate or technical, should be considered by the research or plant engineering department.

Before purchasing general or special machinery for quantity production, the production department should consult or work in conjunction with the plant manager, superintendent, master mechanic, or shop foreman, as the conditions may warrant. These fellows live with the machinery day after day and know the strong and weak points from the practical and detail angle.

The machine and the demands to be made of it should be discussed pro and con and complete data should be collected by the engineer in charge so that the purchase will incorporate all of the important features necessary for maximum production, in minimum time, consistent with ease of operation and control, good vision at points of operation, simplicity, flexibility for changing the operation, accessibilty for repars, current consumption, and final cost.

Responsibility should rest with the plant engineer or master mechanic, as the case may be, to compile all such important data as to the advantages and disadvantages of each piece of contested equipment and finally arrive at the machine best suited for the job.

The engineer should ascertain where the best machine is made. Catalog data should be obtained and studied and, if necessary, arrangements should be made to see the new equipment in operation.

On details in the way of operating faults and advantageous points in a machine, the writer has found it at times to be good practice to discuss these with the machine operator providing he displays the proper amount of intelligence in the matter.

If any improvements are devised the ideas should be taken up with the manufacturers, who usually will make minor changes or improvements.

I believe the method outlined will apply to the majority of large industrial organizations.

THOS. J. SCHREIBER, *Plant Engineer*
J. Schoeneman, Inc., Baltimore, Md.

BUYING a machine at one place and the motor at another will be satisfactory if the machine is to be belt driven. But where it is to be direct connected another story is evident, as will be seen by taking into consideration a few points bearing on the question.

How large is the motor and unit? Can we handle it in our shop? Can we get it to a drill press to drill the unit base to receive the motor and, if there is any machine work to be done, can we do that? Have we the help to handle the job and, if so, is it sufficiently skilled to do the work? Will the manufacturer stand back of his unit if he doesn't ship the unit complete?

If, after a thorough analysis of the pros and cons, it is decided to have the manufacturer furnish the machine and motor as a unit the purchaser should specify the make of motor and type of control equipment to be furnished.

The buying of a complete unit will usually upset the standardization of spare repair parts if the equipment is not specified to be in line with the equipment in use. As an example, when a complete unit is purchased without any specifications in most cases it will mean the immediate purchase of a spare set of motor bearings and spare control parts.

When the unit is left to several contractors to assemble additional complications present themselves. If possible, one of the contractors, preferably the builder of the most delicate or complicated part, should assume the responsibility for the completed unit. This same contractor should be called upon for a final check on the unit in case the purchaser does the assembling.

The manufacturer of the unit should certainly be the one most capable of selecting the parts that will work best on his machine, as he has had experience with them.

In some cases the manufacturer or contractor will prefer furnishing the unit complete to make sure that it is assembled and installed to the best advantage. One case comes to mind where the purchaser installed the motor on a direct connected unit which failed. The manufacturer would not stand the cost of repairs, stating that the motor was not properly aligned, which proved later not to be the case.

It is not my intention to advocate the purchasing of a complete unit in all cases, but it is my opinion that, in most cases, it will pay to buy the unit complete.

About the only disadvantage to the purchasing of a complete unit that is made up from parts furnished by several manufacturers is that the unit may be a highly competitive machine where a few dollars difference in cost may swing the deal to the other fellow, creating a temptation for the builder to furnish cheap auxiliary parts.

MARIN PHILLIPS, *Electrical Superintendent*
International Paper and Power Company
Niagara Falls, N. Y.

POLICIES in connection with the purchase of equipment to be assembled will vary with the type and size of the plant in question. I believe that the small manufacturing plant should always buy its apparatus completely assembled and installed by the contractor. Doing so furnishes the owner an undivided responsibility on the part of the contractor.

The manufacturer is in a better position to buy his equipment in the market, although he may assemble it

K. D. HAMILTON
a contributor to this department. He has written for *Industrial Engineering* over a period of years.

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to fit the customer's needs. Because of his volume in this particular line of business he has buying power which the small manufacturing plant does not have. He is familiar with the various types of equipment on the market and can furnish the customer with the best equipment for the purpose desired.

Larger manufacturing plants present a different problem. There are cases where an entirely new process must be developed. Most large manufacturing plants maintain an engineering department which is capable of designing and assembling equipment.

The larger manufacturing institutions refer such problems to their engineering department, which draws up plans and specifications. It is here that there is an opportunity to save by assembling and perfecting its own design. This is particularly true where the process in question is of a secret nature. The problem can be solved only by buying component parts direct from the manufacturer and assembling them.

I do not recommend that any large manufacturer go into the open market and buy parts for equipment that is of a standard nature. The contractors have perfected their plans and specifications to such a degree in developing standard equipment that the individual manufacturer would find it very expensive to develop for his own particular use the one or two machines which could be purchased at lower prices in the open market.

K. D. HAMILTON, *Mechanical Department*
Geo. E. Keith Company
Campello, Brockton, Mass.

Who Shall Do the Salvaging?

(Question Presented in the December Issue)

THE question of salvage operations in industrial plants is not given the attention to which it is entitled. For some years the scrap metal market has been dull and only during the past year has the nonferrous market advanced sufficiently to give an impetus to salvage operations. Newspaper notices during the past year indicate an increase in losses due to stolen wire and cable which may be easily sold.

In large plants the quantities involved justify the employment of a permanent staff to handle the salvage or reclamation work. In all plants valuable salvaged materials should be in protected storage space.

J. ELMER HOUSLEY
who kicks-in with discussions of many of the Forum's problems, and gets a kick out of doing so.

There are several sources of scrap materials which may be of available and non-available types. Such materials may be broadly classified as follows:

Remnants from new construction
Remnants from rehabilitation work
Obsolete equipment discontinued
Repair parts on hand for obsolete equipment
Obsolete supplies in storeroom stock
Equipment which fails in service
Borings, turnings, melted scrap, paper from shops, and so on.

The remnants from new construction work may consist of short lengths of wire, pipe, and other construction materials. There will be small quantities of usable stores materials. It should be the function of those responsible for the work to forward the non-available material to the salvage center to go into classified scrap. Available material should be returned to the storeroom with a "Returned Material Blank" describing the material and indicating the "Job Order" which should receive credit for the material.

Remnants from the rehabilitation work will consist of similar material with the addition of other material which has been in service for some time and which is ordinarily unfit for further use and will be consigned to classified scrap upon recommendation of those in charge of the work.

Obsolete equipment which is removed from service will in general consist of electrical or mechanical equipment. The respective department heads will, in consultation with the engineering department, indicate whether the equipment is available or non-available for further use. If non-available the material should be written off the books and actually dismantled and junked. The parts of various materials will be properly classified so as to bring the best sale price in the scrap market. If the material or equipment is classed as available a record of it should be made in a special "stores" account and the purchasing department should dispose of the equipment if it is not immediately needed in plant work. If disposition is not made the inventory will be expanded and the value of the equipment will be considered frozen assets, the carrying of which will be a poor business policy. If a determined effort is made to dispose of the equipment, and after a reasonable period it has not been moved, the material should be junked.

Repair parts belonging to obsolete equipment should be removed from the storeroom and proper disposition made at the same time the major items are moved.

Obsolete supplies in the storeroom must be watched closely and at definite intervals the materials should be listed with the purchasing department for them to sell at the best obtainable price. If the material appears unsalable it should be actually broken up and junked so that it may be written off the books. As an example, open knife switches have been discarded in favor of inclosed safety switches and the knife switches should be sold or junked.

Equipment which fails in service is ordinarily put through the shops for repairs and a number of parts may be replaced with new parts. The old parts should be collected and sent to the reclamation center.

Shop and other surplus materials should be collected and sent to the reclamation center at regular intervals.

The ideal organization would be a salvage official working closely with all department heads.

ELMER HOUSLEY, *Electrical Superintendent*
Aluminum Company of America
Alcoa, Tenn.

THERE are two kinds of scrap parts worth considering: Scrap machinery made obsolete due to modernization or reorganization of a plant; and scrap parts eliminated from the process of manufacturing due to complete or partial spoilage.

How to decide about dismantling obsolete machinery depends largely on the attitude of the management as well as on the size of the plant. A large concern, developing and expanding rapidly, will rarely keep old machinery in a "junk yard" very long. If salable, the progressive plant will sell the machinery at the best price obtainable as soon as possible after it has become obsolete for the manufacturing process. Having such machinery standing around for years does not increase its value, and one may find, after some time, that it will cost more to remove it from some inaccessible storage place than the amount obtainable for scrap.

One often finds a smaller or at least less well organized plant intentionally keeping almost all the obsolete machinery in storage, assuming wrongly or rightfully, that there may be further use for it. Needless to say, in such cases the obsolete machinery will invariably be left to itself and will rust and corrode in whatever storage place it is kept. No one will look after it. Thus, should there really come the day when such a relic is brought from its place of decay to the light of the sun, considerable money has to be spent to make it run again. Mostly it has to be rebuilt for some special purpose for which it was, of course, never designed, and much unhappiness results to the maintenance or plant engineer.

Cooperation between somebody representing the management and the maintenance engineer would be very valuable in deciding whether to hold obsolete equipment intact or dismantle it. The importance of such cooperation will be evident from a consideration of how much time is saved by analyzing right at the moment of obsoleting any equipment the reasons for such action, the value of the equipment to present production, and the possibility and effect of immediate disposal. As long as what made certain equipment obsolete is fresh in everybody's mind, a decision is easily agreed upon. Later, considerable effort and

lengthy discussion as to just what to do with "junk machinery" still found in the yard will be required. The longer final decision is deferred the greater "authority" is necessary. The result is unnecessary waste of money, because persons whose business it is to direct an organization are called upon to deal with nasty little details.

A salvage department, if there is one, should take care only of salvaging or disposing of the equipment after it has passed through the maintenance department. The latter should do the dismantling, or at least arrange for it. The maintenance department can undoubtedly much better decide which part of the equipment will, in the near future, be of any use to the plant. In many instances, the salvage department preferably will be a part of the maintenance department, excepting, perhaps, in the case of very large concerns.

The salvaged parts, standard and in such good repair that they can be considered almost first class, should be put in with regular stock rather than kept separate. It is frequently the better practice to use such parts again as soon as possible, because if there exists the slightest doubt that the parts may not be quite satisfactory, they will surely be in a worse condition after having been left in some forgotten corner where they will not be remembered except during inventory time. Separate places for salvaged parts are usually dark holes of no other use. To find just the part at just the moment is next to impossible and takes more time than the part is worth when required.

The plant engineer may be less interested in the disposal of scrap from manufacturing; yet this problem offers a striking parallel to the one under discussion. The salvage department has really nothing to do with this kind of scrap but to salvage or scrap it. Some sorting has to be done somewhere. Therefore, the manufacturing department should be organized in such a manner that the sorting is done at the time of rejection. The operators must be supplied with proper containers for this purpose. The system eliminates tedious and expensive re-handling. The value of immediate decision and analysis, as pointed out before, becomes apparent. That the most direct disposal or routing for salvaging is the best is an established fact.

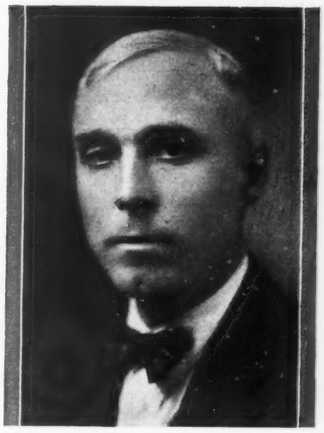
ALFRED STRAUSS, *Electrical Engineer*
Robeson Rochester Corporation
Rochester, N. Y.

Who Shall Do the Oiling?

(Question Presented in the November Issue)

THE answer to this question, as to most others pertaining to the maintenance of industrial equipment, depends upon the size of the plant, and the number of individual units. In a plant employing 50 men, or under, the oiling may well be done by one man having at least some knowledge of what constitutes proper lubrication.

It is customary in some plants, such as grain elevators, etc., to employ one man for all floors above the storage bins and one for all floors below the storage bins. The object is to overcome the lost time in ascending and descending, since there is probably a



H. E. STAFFORD
He has been in the thick of the Plant Engineers' Forum excitement since the inception of the department.

space of from 90 to 120 feet where there is no equipment. It is also the duty of the oilers in a plant of this nature to inspect equipment, blow out motors, and make minor repairs.

In a plant where the number of employees will average from 150 to 300, as in a paper mill, for instance, a different method of handling the lubrication is necessary. Obviously, in a plant of this nature, there are several departments, and it has been found practical to divide the lubricating duties.

It has been found, in industries where a large number of motors are in use, that the motor lubrication should be under the supervision of the electrical department, and a record kept showing the lubricant used, the times for lubricant renewal, and the condition of the lubricant and bearings. In one industrial plant, where a record is kept, the yearly cost averages 50c per motor for lubricant, $10 per motor for lubrication and inspection labor. If figures showing the cost of similar work in other plants were available they would be welcome.

The lubrication of other machinery and line shafting may be accomplished by one man, or less, per department, per shift, depending upon the size of the department and number of units. If two departments overlap, and one man can readily handle two or more departments and still do justice to the equipment, the cost of lubrication may be lowered; but experience has shown that proper lubrication consists of more than merely squirting oil or doping a bearing with grease occasionally. It should not take an oiler very long to discover the bearings that require the most attention, and the necessary amount of lubricant to use at each inspection.

Where an oiler looks after several departments, he should be under the supervision of the master mechanic, but where there is an oiler for each department he should be responsible to the foreman of that department.

To recapitulate: Present-day lubrication is more of a science than a mere job. An oiler, in the first place, should be given to understand something of his responsibilities, should be able to tell one kind of oil from another, understand something of the chemistry of oil and grease, what kinds of lubricant to use on different applications, when to discard or renew the oil or other lubricant in a bearing, and keep a record of the time of such change and the condition of the bearings under his care.

H. E. STAFFORD, *Electrical Engineer*
Port Arthur, Ont.

• QUESTIONS •

Asked and Answered by READERS

•

How Protect This Floor Against Acid?

In our plating room we use muriatic and hydrofluoric acid, which are constantly running over the floor composed of sand and a composition similar to asphalt.

Every two months this floor must be replaced because of the destructive action of the acid. I shall appreciate receiving information as to what can be done or used to secure a satisfactory flooring that will not be constantly destroyed by the action of the acid.

LaCrosse, Wis. W. M. D.

What Causes One High Bar in a Commutator?

We are having trouble from brush chatter caused by one high bar in the commutator of a 115-volt, 125-amp., 1,100-r.p.m. d.c. generator. Is there any way to remedy this condition without turning the commutator down in a lathe? The commutator is 9¾ in. in diameter, with a 6-in. face. What causes one bar to become high, and how can I prevent it? O. C. H.

New Orleans, La.

Carrying Capacity of Wires

In the standard wire tables the allowable carrying capacity of the different sizes of wires and cables is given as so many amperes, depending on the class of insulation used. For example, a No. 1 wire has an allowable capacity of 100 amp. with rubber insulation, 120 amp. with varnished cambric insulation, and 150 amp. with other classes of insulation. Assuming that these are the capacities at 110 volts, what would be the capacity at 440, 1,100, or 2,300 volts? I wish someone would explain how the voltage affects the figures for carrying capacity given in the wire tables. J. H.

St. Joseph, Mo.

Small D.C. Generator Heats Under Normal Load

We are having trouble with a d.c., 125-volt, 1,750-r.p.m., ¾-kw., 6-amp., four-pole, compound-wound generator. This generator was rewound, but the new winding is the same as the original, so far as anyone knows. The armature coils are wound with eight turns of four No. 20 d.c.c. wires in parallel. The coil pitch is 1-and-6. The commutator has 83 bars and the pitch is 1-and-42. There are 21 slots in the armature. The generator picks up before it reaches full speed, but has a very bad hum, as though working under a heavy load. The hum is present when the machine is and is not carrying a load. It will maintain the correct voltage under a load of 6 amp., but the commutator heats up rapidly and would probably throw solder within 30 min. The armature has been tested for shorts, grounds, and opens, and is free from them. The field coils have been tested for shorts, grounds, and polarity, and are OK. The brushes are set exactly at the quarter. If the generator is run at 1,200 r.p.m. it will carry the load at 120 volts without heating, but still hums badly. We use this generator for exciting a magnetic separator and need it badly. Can someone tell me how to locate and remedy the above troubles?

St. Joseph, Mo. E. F. S.

Drive for Air Compressor

We are getting ready to install a new air compressor, but have been unable to decide on the best method of connecting it to the motor. The compressor is to be driven at 248 r.p.m. by a 100-hp., 890-r.p.m. motor. The center distance between shafts is 60 in. The compressor will be used practically continuously and we want to use the most reliable and efficient method of driving it. What form of connection would readers recommend?

Youngstown, Ohio B. S.

How Can Sweating of Outside Walls Be Eliminated?

We have a five-story brick-and-steel-construction mill building with a stairwell about 45 ft. long and 20 ft. wide in one corner. This stairwell is not heated and we experience considerable trouble from sweating of the outside walls in winter. At present we have to repaint the walls every spring. A 6-in. cast-iron toilet vent in one corner of the stairwell sweats so badly that the platforms become slippery and dangerous. Heating the well would overcome the trouble, but it would be rather expensive and I am wondering if other readers have had the same trouble and have devised some method of treating the walls and pipes. J. F. W.

Easthampton, Mass.

Do Shorted Field Coils Cause Motor to Heat?

We have been having trouble with a 2,200-volt 450-hp. synchronous motor whose fields are excited at 125 volts. This trouble is principally over-heating, although the motor is not overloaded. Apparently the field coils are to blame, that is, same may be short circuited, but there is no visible evidence to substantiate this conclusion. With this information, is it possible for some reader to explain how it is possible to locate the source of trouble in a practical manner. G. H. P.

Camden, Ark.

Locating Trouble Without Disturbing Internal Connections

Will some reader explain how it is possible to locate grounded, shorted, or open circuits in induction motors without disturbing internal connections?

We have the usual assortment of instruments such as d.c. and a.c. ammeters, voltmeters, millivoltmeters, and a 35,000-ohm magneto. However, the magneto has been found impractical for slight grounds, and our budget does not call for a megohmer.

Using an a.c. voltmeter to ground on our three-phase, 60-cycle, 220-volt motors was also found impractical. How can satisfactory results be obtained under the circumstances?

Syracuse, N. Y. G. A. G.

Grounding 220-Volt, Three-Phase System

I wish readers would tell me the advantages and disadvantages of grounding one phase of a three-phase, 220-volt, 60-cycle power system in an isolated power plant. In this plant we have an auxiliary power service in which one phase is permanently grounded. The capacity of our power plant is 600 kva. The motors range in size from fractional to 100-hp. rating, and about 40 per cent are controlled by magnetic switches. There is also a 100-kva. load in lighting transformers.

St. Louis, Mo. P. J. G.

ANSWERS *to* QUESTIONS

Trouble in Connecting Motor for Two-Speed Operation

I should like to know why I have had trouble in connecting a Crocker-Wheeler Type SC, 220-volt, 820/1, 760-r.p.m., three-phase motor. The stator has 36 slots with 36 coils arranged in twelve groups of three coils each. The span is 1-and-6, and the coils are connected single-circuit delta and two-circuit star, six leads being brought out. I first used the 1-and-3 jumper, top-to-top connection, instead of the 1-and-6 jumper connection shown in Fig. 136 on page 185 of Dudley's "Connecting Induction Motors." The motor operated satisfactorily on the two-circuit star connection, but with the single-circuit delta connection it ran hot and hummed loudly. After changing to the 1-and-6 jumper connection the motor operated properly at both speeds. What I want to know is, why was the 1-and-3, top-to-top connection not satisfactory? E. J. R.
New Orleans, La.

THE diagram in Fig. 136 of Dudley's "Connecting Induction Motors" referred to by E. J. R., shows a two-speed, single-winding, four-and eight-pole—two-parallel star for four poles and series delta for eight poles—connection. First I might say that E. J. R. refers to a 1-and-3 and 1-and-6 jumper connection. This should be 1-and-4 or 1-and-7; so I am assuming that this is a typographical error. Also, as he states that the book connection worked satisfactorily, I assume that he has grouped the coils for twelve pole-phase groups.

All two-speed, two-parallel and series-connected single windings must use the long, 1-and-7, jumper as this top-to-top connection divides the winding into two halves, one half having all the north poles and the other half all the south poles. The parallel connection lead is attached to the short, top-to-bottom reversing *(RJ)* jumper, and the ends of each half are connected to the star ring. The current divides both ways, as Fig. 1 shows.

This connection gives the proper salient-pole arrangement and the all-in check proves that it is correct.

For the series, consequent-pole connection, the lead *D* is left open and lead *C* is used as a line lead. The dotted arrows in Fig. 1 show that the polarity of groups *2* and *8* has been reversed, making them north poles; inasmuch as groups *2* and *8* are directly opposite each other, all of the groups are north poles, making a consequent eight-pole connection.

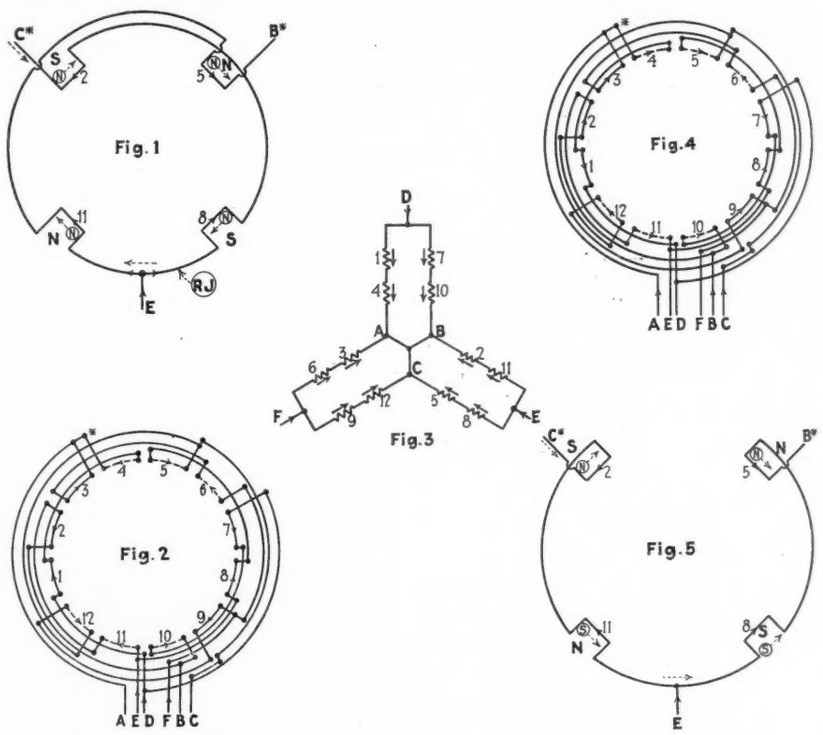
Fig. *2* shows the salient four-pole, top-to-bottom (T-B) or 1-and-4 connection, with *E, D,* and *F* as line leads, and *A, B,* and *C* connected together for the star. The all-in check shows the two-parallel star connection to be correct. Fig. 3 shows the schematic diagram for Fig. *2*; thus the 1-and-4 short jumper will work for the four-pole winding.

Next, Fig. 4 shows the all-in check applied to the 1-and-4, top-to-bottom, short-jumper, series-delta, eight-consequent-pole connection. To be correct all the arrows should point in the same direction, with *A, B,* and *C* as leads, and *E, F,* and *D* open. However the arrows in groups *12, 2, 3, 4, 5, 7* point clockwise, and in the remaining six groups they point counter-clockwise.

Thus, the 1-and-4 jumper does not reverse the correct groups to form eight consequent poles, and Fig. 5 when compared with Fig. 1 shows that instead of opposite groups being reversed, adjacent groups *2* and *11* are reversed, making the group polarity N-N-S-S, which is incorrect for eight consequent poles.

Thus for correct operation the long, 1-and-7, jumper as per Fig. 136, in Dudley's book must be used.

Wilkinsburg, Pa. A. C. ROE.



These diagrams show why the long, 1-and-7, jumper must be used on all two-speed, two-parallel and series-connected, single windings

Location of Idler Pulleys

We have several old air compressors driven by 25- to 50-hp. motors through leather belts. The motors and compressors are mounted on a common foundation, the distance between the shafts ranging from 8 ft. to 12 ft. The compressors are equipped with an idler pulley. In one case the idler is about the middle of the belt and in the other drives it is about two-thirds of the distance between the compressor and motor, being closer to the motor. The compressors are running at full load or more and the belts are giving trouble from slippage and wear. Increasing the weight of the idler does not help much and I think the idlers should be placed closer to the motor pulleys, but do not know how much closer to them. Is there any formula or rule that I can use to locate these idlers the proper distance from the motor pulley? J. C. D.
Cincinnati, Ohio.

REPLYING to J. C. D., I can give him a few hints acquired from actual experience with similar idlers. I have in my care seven drives similar to the one described. Six are used with 40-hp., 575-r.p.m. motors connected to the crank drives on gang saws; the other is used with a 100-hp., slip ring motor connected through an endless belt to a two-stage compressor.

Our idlers consist of cast-iron pulleys with a 9-in. face, mounted on cold-rolled steel shafting. Bronze bushings are used in the pulley. The belt speed is 1,275 feet per minute.

In all cases the bottom of the belt is the tight side. The idler pulley is placed close to the motor pulley, leaving only sufficient clearance to allow the idler pulley to fall to the floor in case of belt breakage. The bottom of the idler pulley should be just high enough to clear the tight side of the belt, thus getting the benefit of a large

ANSWERS *to* QUESTIONS

arc of belt contact on the motor pulley.

I have found that a heavy flywheel is highly important on compressors and similar drives. If the flywheel is too light, the pulsations of the driven machine will cause the idler to dance up and down and throw very serious strains on the belting—causing frequent breakage. A heavy flywheel will smooth out these pulsations and result in a better-running drive.

Chief Electrician, CHAS. A. PETERSON.
Cold Spring Granite Company,
Cold Spring, Minn.

REPLYING to J. C. D., he is correct in believing that the idler should always be placed as close as possible to the motor pulley. In laying out these drives, the general rule is to place the idler as close as possible to the smaller-diameter pulley, regardless of whether it is the driving or driven pulley. Where the motor is on a sliding base, it is customary to mount the idler also on a sliding base so that it may be moved at any time the motor pulley is moved. The position of the idler pulley should be such that there will be a minimum clearance of 1½ to 2 in. between the faces of this pulley and the motor pulley.

When the drive is not running the motor should be pulled back so that the distance between the idler and the tight side of the belt is one-half the diameter of the smaller pulley. This position will give a minimum wrap around the smaller pulley and at the same time provide enough movement for the idler to take care of the elongation in the belt under varying loads.

Chief Engineer, ROY C. MOORE.
Chas. A. Schieren Company,
New York, N. Y.

Will a Larger Motor Be Needed on This Job?

We use a boring machine that has two main shafts, each of which is driven separately at a speed of 1,500 r.p.m. by a 20-hp., 1,500-r.p.m. motor, through a belt. Each shaft carries 24 bevel gears, which in turn drive 24 bits, all of the same size. Would it be possible to replace one of these 1,500-r.p.m. motors with a 20-hp., 750-r.p.m. motor, using a 24-in. pulley on the motor shaft and a 12-in. pulley on the machine shaft to obtain the proper shaft speed? Or would I have to use a 750-r.p.m. motor of more than 20-hp. rating? In other words, will the necessity of increasing the motor shaft speed also make it necessary to increase the horsepower rating of the motor used? Perhaps some of your readers have experienced a similar problem. C. H. F.
Wilmington, Calif.

IN answer to the question by C. H. F., increasing the motor speed will not change the horsepower required, if the pulley ratio is changed so as to keep the machine speed the same as it is now.

The reason for this will be seen when it is considered that changing the motor speed and keeping the machine shaft speed the same do not increase the rate of speed at which the work is done.

Except for a possible slight change in the efficiency of the speed-reducing unit, the horsepower required to drive the machine will be increased only when the speed of the machine shaft is changed, all other conditions remaining unchanged. R. P. GUILDFORD.
General Engineer,
Westinghouse Electric & Manufacturing Company
Philadelphia, Pa.

Method of Heating Oil Pipe Line

We have a 2-in. pipe line 120 ft. long that supplies crude oil to some of our furnaces. The supply tank is equipped with a steam coil to keep the oil at the proper temperature, but during cold weather the oil standing in the pipe overnight becomes cold and thick and we have trouble each morning starting our furnaces until the pipe line is heated. I should like to know, (1) if it would be possible to use some form of electric heater to keep the oil in the pipe line warm. If so, please give me suggestions on how to make it. We have 220 volts a.c. and 110 and 220 volts d.c. available. (2) What other method of heating this pipe line would be practicable?
Chicago, Ill. J. J. E.

IT would be possible without any particular difficulty or great expense to apply electric heating to the pipe line referred to by J. J. E. No details are given about the characteristics of the oil, such as the minimum temperature at which it will flow, and the specific heat.

Two methods may be used to keep this pipe warm enough to maintain the oil in a liquid condition. One method would be to heat the whole length of pipe by passing current directly through it. The other method would be to lay the pipe in an insulated box section with strip heaters directly below it, throughout its entire exposed length. The exact value of energy required cannot, of course, be calculated without knowing the factors involved, although in my opinion an energy consumption of less than 1 kw. should be enough.

I have used the first method referred to, that is, passing current directly through the pipe, for heating water and air as well as oil. Current at less than 50 volts was obtained from the low voltage secondary of a thawing transformer and adjusting the current on the high-voltage side by means of a choke coil with a standard iron core until the desired temperature was obtained. Insulating joints were placed at the ends of the pipe sections to prevent any possibility of current flow beyond the section involved.

In a recent instance a 7,500-gal. oil container about 25 ft. long, was heated by means of ordinary resistance grids, placed directly below it in a heat-insulated space and the tank itself insulated.

It would, of course, be possible to run a small steam line under the oil line for its entire length in a manner similar to that suggested in the second method; the two pipes should be placed in the insulated box section. However, this method has the disadvantage that there may be leakage of steam unless the pipe is kept in continuous service, summer and winter. The method of heating the 7,500-gal. tank previously referred to was chosen because of the difficulty of keeping a steam line tight all the year 'round.

C. O. VON DANNENBERG.
New York, N. Y.

IN my opinion J. J. E.'s problem should be a very simple proposition. Let us consider the usual crude oil storage tank installation. In such an installation the storage tank is usually underground, and I assume the tank J. J. E. refers to is also underground. As he mentions, the tank is equipped with a steam heating coil. Now then, presuming that the tank is located outside the building, one must run both a steam line and a condensate line, from a point in the building near the tank, to the tank itself. If the oil line is also buried underground, it is usual practice to bury the steam and condensate lines along with the oil line in the ground, or if one wants to go to the expense, put the lines into a pipe conduit.

The first method is the one usually followed on short-distance installations. In case the pipe lines are overhead, the latter method should be followed. In either case, as the oil in the tank must be kept warm, the combined heat of the steam and condensate lines will also keep the oil in the pipe line warm at all times.

If the crude oil is shipped in tank cars, J. J. E. will find that during the winter time the oil in the tank car will get very thick. In such cases it will be necessary to bring a steam supply line to the tank car. These tank cars are equipped with a heating coil inside the tank, and it will be necessary to heat the tank first, before the oil will flow in the pipe line. Here again the steam and condensate lines should run alongside the oil line going from the tank car into the storage tank.

This method of keeping the oil lines warm is the easiest way of doing it, because the steam has to be supplied to the storage tank in any case, and it is also the safest way.

Chief Draughtsman, F. W. PAFFEN.
Canadian Celanese, Limited,
Drummondville, Que., Canada.

On the Front Cover

PICTURED this month is the new plant of the Industrial Rayon Corporation at Covington, Va., especially equipped for the manufacture of fine denier and multifilament yarns by the viscose process. Based on the production of 150-denier yarns, the plant has an annual capacity of 6,000,000 pounds.

There are about 1,500 employees at present. The plant engineering and maintenance crew numbers 125. Operating and maintenance forces must work in harmony since many of the operations are continuous, requiring that the equipment be operated 24 hours per day, 365 days per year.

The Manufacturing Department sets the production schedule based on available equipment and the Maintenance Department handles the inspection and repairs. By means of systematic lubrication, cleaning, and inspection, a minimum number of spare machines is required. A definite inspection schedule is maintained and the men doing the inspection make written reports which include comments concerning the condition of equipment and proposed maintenance work.

Expert handling of material in the various stages of manufacture is required on account of the nature of the processes. Each hour of the day is covered by some members of the maintenance crew in caring for such important details as time, temperature, and humidity.

In addition to the duties enumerated, the Maintenance Department handles inbound freight shipments, cares for factory supplies, looks after the janitor work and sewerage. Practically all trades are represented; they include power house engineers, firemen, painters, carpenters, lead-burners, pipefitters, tinners, electricians, blacksmiths, welders, machinists, millwrights, tool makers, and brick layers.

Rayon manufacture is a laboratory process handled on a production basis. Positive control of temperature, humidity, and chemical analysis is essential. Air conditioning is handled through six central stations. The air in rooms covering more than 225,000 sq.ft. of floor space is controlled for both temperature and humidity. The scope of this activity may be judged from the fact that from one room alone over 200,000 cu.ft. of air per minute is exhausted.

Water, a vital requirement, is obtained from a small lake formed by a dam in the river. The pumps can handle six and a quarter million gallons of water per day. A filtration plant handling three million gallons per day is operated.

Several buildings, independent but inter-communicating, inclosing more than 400,000 sq.ft. of floor space comprise the plant. The main building is one story 332x727 ft., is built of brick, and has sawtooth roof construction. Face brick is used in the exterior wall panels between the steel sidewall sash, while the interior walls of the main building are lined with white enameled brick which not only reflects the light, but also is easy to clean. This white tile wainscoting extends to a height of 5 ft. throughout the main building, except in the finishing department, where it extends to the ceiling.

On account of the chemical processes employed in the spinning room, a 2-in. mastic top floor has been placed on the concrete base floor. In the textile department a maple top floor is used over 3-in. vacuum-creosoted pine laid on a tar concrete base. Approximately 530,000 sq.ft. of roof-insulation board was used in the mill buildings for the purpose of preventing ceiling condensation, stopping fuel losses, and maintaining productive temperatures.

Power is generated for the operation of more than 400 motors and steam is used in processes. Pulverized coal is the fuel. All air compressors, vacuum pumps, and refrigerating machines are housed in the power houses and a loop system of tunnels distributes vacuum, air, and power to all departments.

1930 Congress and Exposition for Cleveland

CLEVELAND, OHIO, in all probability, will be the location of the 1931 National Management Congress and National Industrial Equipment Exposition. The auditorium will afford ample housing facilities, and the geographical position of the city will be an asset.

It is expected that the congress will be conducted along the lines followed this year, under the auspices of several national management and engineering societies. According to the outlook at present the Materials Handling Division of the American Society of Mechanical Engineers will hold its national meeting in conjunction with the congress.

The Midwestern Engineering Exposition, with headquarters at 308 W. Washington St., Chicago, will conduct the exposition.

Melting Platinum New Light Standard

A NEW and exact method of measuring the intensity of light has been perfected by the United States Bureau of Standards. Pure platinum at the fusing or melting point supplies the new standard for measuring illumination.

Its adoption will supplant the somewhat undependable comparison with a group of electric lamps which the bureau has closely guarded for a score of years as the "international candle." A group of 46 lamps was set aside in 1907 at the bureau as the standard of comparison with all other sources of light. These lamps were divided into eight groups and each lamp given a candlepower rating. All the lamps in each group had the same voltage, though there were three different voltages in the entire group. Careful as the bureau was with these standard lamps, one was broken and the 45 remaining showed on successive occasions a variation in the amount of illumination they produced despite the fact that they have not been burned more than twenty hours in nearly a quarter century.

In contrast to these standards, that supplied by the molten platinum method has the great virtue of being reproduceable exactly at any time, the only requisite being pure platinum. In its pure state the metal always will fuse at 3,220 deg. F. In the experiment which established the new standard the platinum was chemically pure to within four parts in 1,000,000. Under ordinary circumstances, purity to within one part in 10,000 is considered highly satisfactory.

The brilliance of the molten platinum is observed during the ten minutes elapsing just before it returns to the solid state. By means of photometric comparison the light emitted by the molten platinum is compared with the lamp standards.

Power Drive Analysis

Conditions Favorable

By WILLIAM STANIAR

Mechanical Power Engineer
E. I. duPont de Nemours & Company, Wilmington, Del.

HEREWITH:

A typical drive layout for a plant with favorable operating conditions

COMING:

An analysis from the standpoint of unfavorable conditions

IF the transmission and distribution of mechanical power are considered fundamental necessities and not accessories in the design and layout of new industrial plants, the engineer has under his control, based on the methods known and the equipment available, the opportunity to place in service efficient and economical systems adaptable to any requirement.

At the conception of a new industry or the expansion of an existing one, whether it involves process operations, progressive assembly, or machine-part manufacture, the flow sheet of operations is generally the first procedure, because such a beginning immediately provides means for determining the extent and proportions of buildings and the location and size of apparatus required. It is at this stage of the design that the transmission of power mechanically, should be considered so that the actual building structure can be designed around an efficient transmission system instead of such a system being designed to suit the building.

A new plant presents an opportunity for the employment of the most modern methods of transmitting power; therefore, each problem should be analyzed thoroughly before a selection is made, otherwise an error will manifest itself continually, not only in high maintenance costs, but also in retarded production. In analyzing drive requirements naturally the first question that arises is whether to direct connect motor to machine, use gear reduction units, or distribute by the group system of shafting, belting, and chains. Experience has taught conclusively that the relative merits of group and individually connected drives are primarily a question of economy of investment, flexibility in operation, and adaptability to service conditions. Numerous articles and discussions have been published as to the relative merits of the two systems, but in actual practice the decision is based on the drive best suited for the application in question, and such decision is frequently influenced by personal

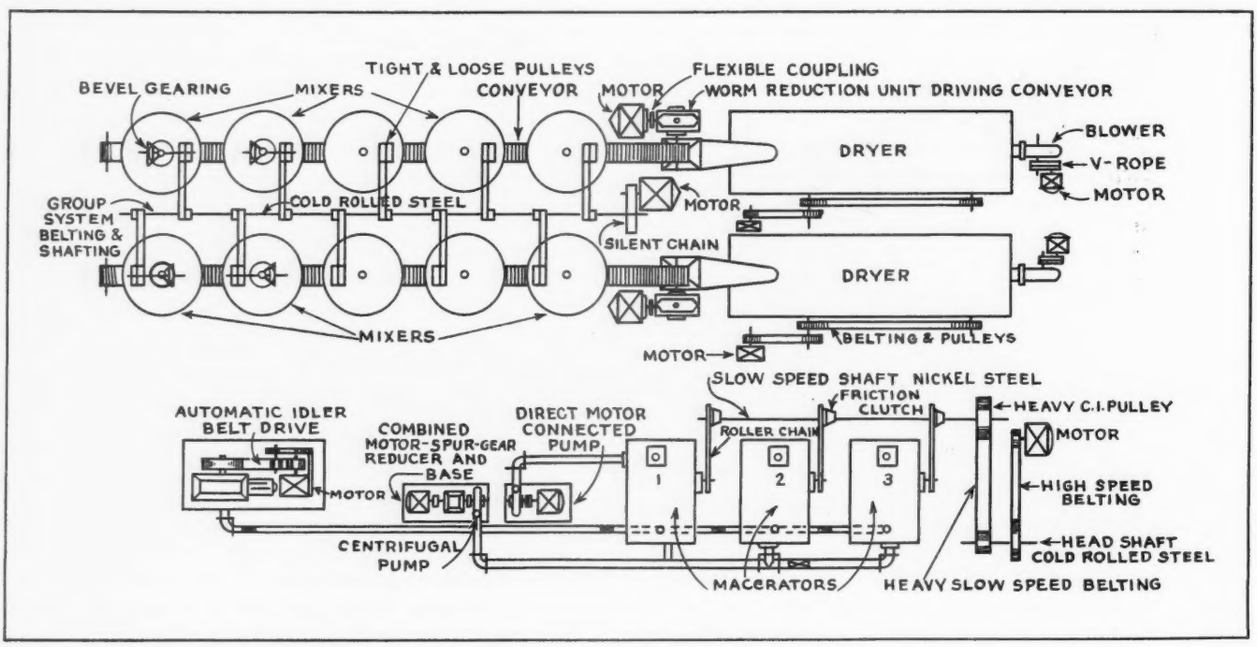


Fig. 1—Plan showing typical layout of a process manufacturing plant equipped with modern mechanical power transmission units, and illustrating ease of application.

preference, general appearance, or possibly some other reason entirely remote from the transmission field. In view of these facts, I will not differentiate between the two systems, but will attempt to show that modern manufacturing equipment and methods necessitate the use of both group and individual driving.

Transmitting mechanical power in process manufacturing plants such as are encountered in the various chemical industries is not comparable with that of the production, machine-part plan because the former consists of a wide range of apparatus design, whereas the latter is generally composed of heavy individual machines and batteries of small machine tools working at similar speeds and motions. In view of this divergence they will be considered separately.

A plan layout of a typical process manufacturing plant is shown in Fig. 1, in which the transmission of power has been carefully thought out in the early stages and then designed and selected to suite the requirements and not, according to general practice, to suit the building and all other seemingly more important items of construction. The flow sheet of this particular plant revealed that the first operation was mixing, requiring ten individually controlled slow-speed mixers arranged as shown. The second operation was the removal and transfer of the mixed material to the driers with the aid of slow-moving belt conveyors. The driers were to be equipped with a system of internal-gear-driven conveyors traveling at a slow speed against a blast of hot air. The third operation was to inspect the dried material and place it in slow-speed macerators. During maceration a solution of certain chemicals and a jet of compressed air must be introduced.

It was evident immediately that no one system of mechanical power transmission could efficiently meet the demands of such a layout because of the wide variation of speeds and motions. In view of the foregoing an analysis of the three major operations was necessary. To individually drive each of the 10 mixing tanks was not practicable because the starting load on each tank was 5 hp. and the running load 3 hp., which would require an aggregate of 50 hp., plus the necessary reduction gears, starting equipment, and the possible future electric maintenance. With the shafting and belting-group system one 30-hp. motor could readily handle the load because the entire battery of mixers would not be operating simultaneously. To conserve space the line shaft was driven by an encased silent chain from the motor.

Based on the foregoing, the 10 mixers were driven by the group system as shown in Fig. 1. The conveyors were to operate at such a slow speed that belt driving was economically impossible, resulting in the adoption of high-ratio, worm-gear reduction units, each flexibly coupled to 10-hp. motors operating at 1,200 revolutions per minute.

Driers of a certain class involve two driving problems; one is the slow-speed, internal conveying arrangement, the other is the introduction of hot air at high velocity. In the driers shown, two internal conveyors were necessary, arranged at different elevations and operating at the same speed. Here the belt-connected motor drive is the most feasible and economical installation because of the low power requirements and simplicity of operation.

Macerators usually require considerable power to drive them, and the method employed must be flexible, so that shocks can be readily absorbed. For this reason, in a battery of such machines, direct connection should not be employed. Each macerator used in the layout under discussion required 22 hp. They were to be individually controlled at a speed of 32 r.p.m., which eliminated the possibility of belt connection to the driving shaft of the machine because at 32 r.p.m., the width of belt required to transmit 22 hp. would be prohibitive. Under these circumstances recourse must be made to the finished-steel roller chain, friction-clutch controlled, which necessitates the installation of a heavy-group driving system. The three macerators totaled 66 hp. which, based on the friction load of the group system, required a motor of 75-hp. capacity. In a group system of this character ratios over 3 to 1 should not be considered; therefore, figuring on a motor speed of 860 r.p.m. at full load, the head shaft must operate at 286 r.p.m., and the line shaft at 95 r.p.m. This combination based on a 3 to 1 ratio for the chain connection, results in 32 r.p.m. at the machine. The head shaft of this group operates at a fair speed which economically allows the use of cold-rolled steel, but the line shaft operating at 95 r.p.m. and transmitting 75 hp., with shock, would require cold-rolled steel of large diameter and with proportionate accessories.

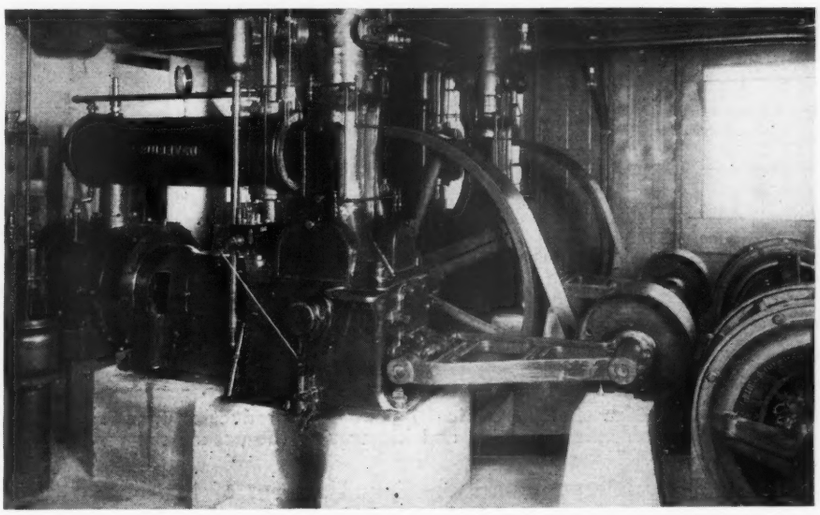


Fig. 2—This method was utilized in driving the compressors shown in Fig. 1. It is a short-center application employing an automatic-idler pulley.

Macerator No. 1 of this battery required its chemical solution delivered at high velocity which necessitated the use of a high-speed centrifugal pump. The driving of such a pump was solved by direct connecting a 1,200-r.p.m. motor by means of a flexible coupling to the pump, the entire unit being supported integrally on one base plate.

Macerators Nos. 2 and 3 required their chemical solutions at a lower velocity; therefore, to employ the same size and style of centrifugal pump as used for No. 1 macerator, it was necessary to operate it at a lower speed. This speed reduction

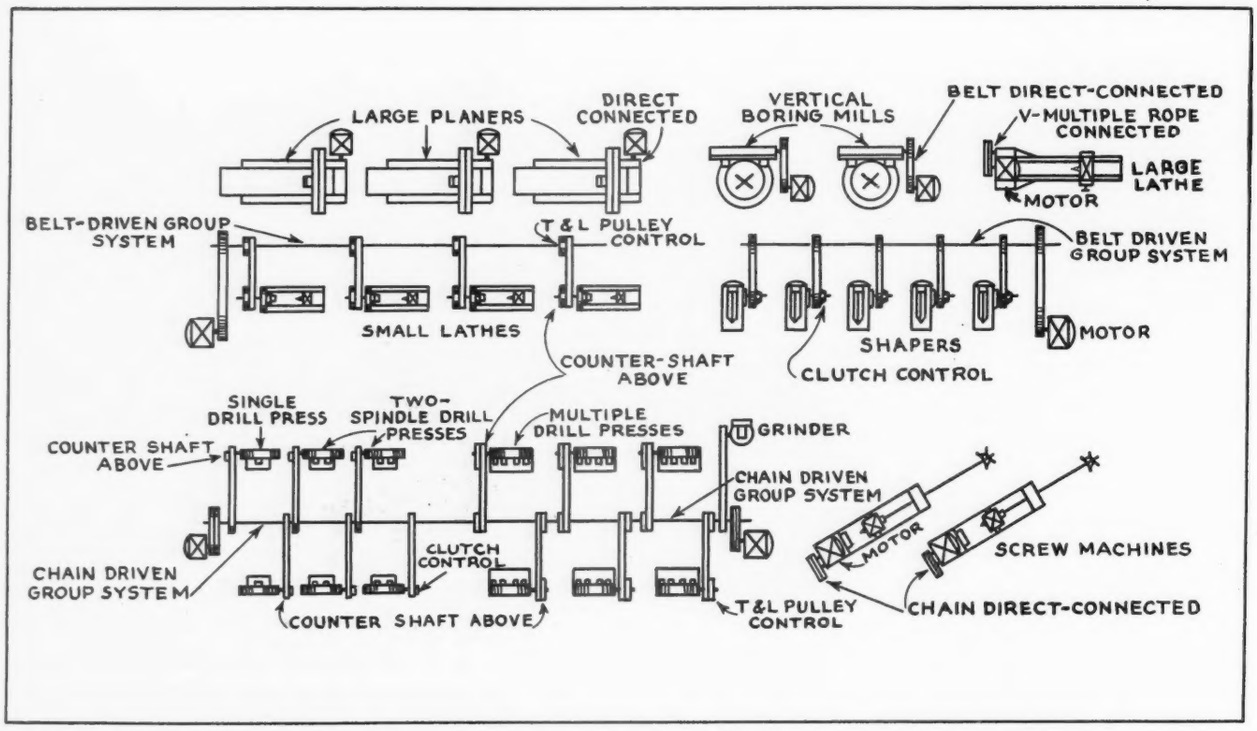


Fig. 3—Plan showing typical layout of a production-type manufacturing plant equipped with modern power transmission units, and illustrating the use of the various systems to suit the requirements.

was obtained by interposing a spur-gear reduction unit between a 1,200-r.p.m. motor and the pump, all flexibly coupled and integrally supported on one base plate.

As a reaction agent in this maceration process air was required at varying pressures of from 75 to 125 lb., which necessitated an air compressor of suitable capacity. Based on the variation of load the compressor was driven by a direct, belt-connected motor equipped with the automatic-idler system, as illustrated in Fig. 2, because of the close center involved and to compensate for the fluctuating tensions in the belt.

The analysis of the drive problems as presented in the layout shown in Fig. 1 prove conclusively the advantage of considering the various methods of power transmission available at the flow-sheet stage of design. With this procedure power transmitting mis-fits can be eliminated because there will be no congestion in employing the most economical, efficient, and modern equipment for the service rendered.

In planning the arrangement of machine tools in a new production-type manufacturing plant the routing diagram corresponds to the flow sheet of the process manufacturing plant. Such a diagram is planned so that the parts will move from one operation to another with the minimum amount of handling and lost motion. It is at the completion of the routing diagram that the transmission of mechanical power should be considered, because the type of machinery being used and its arrangement are pertinent to the selection of the transmission system.

A plan layout of a typical production-type manufacturing plant is shown in Fig. 3. The classes of machine tools and their arrangement based on the routing diagram have been analyzed so that the most efficient and economical system of power transmission could be utilized without the hindrance of structural interference. The large tools in this layout consist of planers, vertical boring mills, and a large lathe, whereas the small equipment is made up of small lathes, shapers, single- and multiple-drill presses, and screw machines. Equipment such as this can be driven by either the direct or group system or a combination of the two. It is true that the direct system throughout has an appeal because of appearance, mobility, and the absence of overhead shafting and belting, but it lacks economy where batteries of small machine tools are necessary. These batteries must be motorized, based on the starting loads of the various machines. With the shafting and belting-group system the motorization can be based on the running loads. This condition is the real economical difference between the two systems.

Generally, the direct system requires the motor on each machine to have excess capacity. This condition is of small consequence where one or two small machines are involved, but it must be considered when applied to batteries of tools or machines because the charge for power is partially based upon the demand and power factor in addition to the load rate. The demand charge must be paid whether the machines are operating or not. Low power factor implies inefficient operation and it is caused chiefly by over-motored machines.

When it is a question of driving machine tools that require from 10 to 25 hp., it is just as uneconomical to drive them by the group system as it is to drive batteries of small machines individually. Large machines should be individually motorized, even though over-motorizing may occur.

Advantage has been taken of the various methods of individual and group driving available in the layout as shown in Fig. 4, and the selection has been based on the foregoing analysis.

All three planers of this plant required 20 hp. each, and based on the necessary reversing action of such

a machine they were individually driven by 20-hp., d.c. motors, resulting in an efficient and economical installation. Two vertical boring mills requiring 15 hp. each, were driven by individual belt-connected motors because they were not of recent design, otherwise they would have been flexibly coupled to the motor direct. The large lathe being a modern unit was direct connected to a 10-hp. motor through an integrally encased multiple V-rubber rope system. This arrangement of large tools required motorization equal to 100 hp., which possibly could have been accomplished with two 40-hp. motors if driven by the group system, but it would have necessitated an entirely different arrangement of the plant, and consequently higher costs.

With the exception of two screw machines the remainder of the production machinery was driven by the group system. Four small lathes, each requiring 3 hp. on starting and 2 hp. when running, were driven by a 10-hp. motor hung from above and belted to a group line shaft which in turn was tight- and loose-pulley belt connected through overhead countershafts to each lathe resulting in a most efficient installation. A similar procedure was followed in the driving of the battery of 5 shapers with the exception that each shaper was clutch controlled. This installation required a 15-hp. motor, belt connected to the line based on a 3-hp. running load for each machine. An example of a group line-shaft system is shown in Fig. 4.

Two batteries of drill presses were required; one consisting of two single-, and four two-spindle units, whereas the other was composed of six four-spindle units. The former units were designed for clutch operation and the latter for tight- and loose-pulley control; therefore, based on the adoption of the group system of driving and routing diagram arrangement, it was either necessary to provide individual overhead countershafts for each drill or one countershaft for each battery of three. The individual countershaft was selected because of the ease of possible location change. Where space requirements are available there is practically no argument against belt-connecting the motor to the line shaft of the group; that is, if the proper type of endless belting is employed. The arrangement is highly efficient, operates smoothly, and requires little maintenance. In view of the foregoing it is really a matter of first cost or personal preference on the part of the engineer as to whether the belt or inclosed silent chain be used. However, if the connection can be made in one reduction and little space is available the silent chain will solve the problem.

In the layout shown in Fig. 3, the motors are silent-chain connected to the line shafts driving the drill presses as a means of illustrating the chain-driven group system. In this particular installation the lines in reality were belt driven because ample space was available.

Individual driving of screw machines and automatic turret lathes has solved a troublesome problem of group-belt driving that has long been in evidence. Based on the class of work involved, such machines are generally arranged on an angle, as shown in Fig. 3, so as to facilitate the handling of the bar stock required. The older designs of screw machines were belt driven through individual countershafts from a group line which necessitated that either the belt from line to counter, or from counter to machine must have a certain amount of twist to compensate for the angle of the machine. The general practice, however, was to twist the vertical belt from the countershaft to the machine which resulted in a troublesome installation. In the modern plant, regardless of over-motoring or low power-factor conditions this type of machinery should always be individually motorized as shown in the layout. In this particular installation the screw machines were direct, silent-chain connected from a motor integral with the machine, but such a drive is not necessarily standard practice because all methods are sound. However, the selection is usually left to the discretion of the machine manufacturer.

As a rule, the analysis of the driving problems in a production plant is to determine the most advantageous uses of either the group or direct systems based on the factors involved. In this class of driving it is poor economy to entirely discard the use of either one.

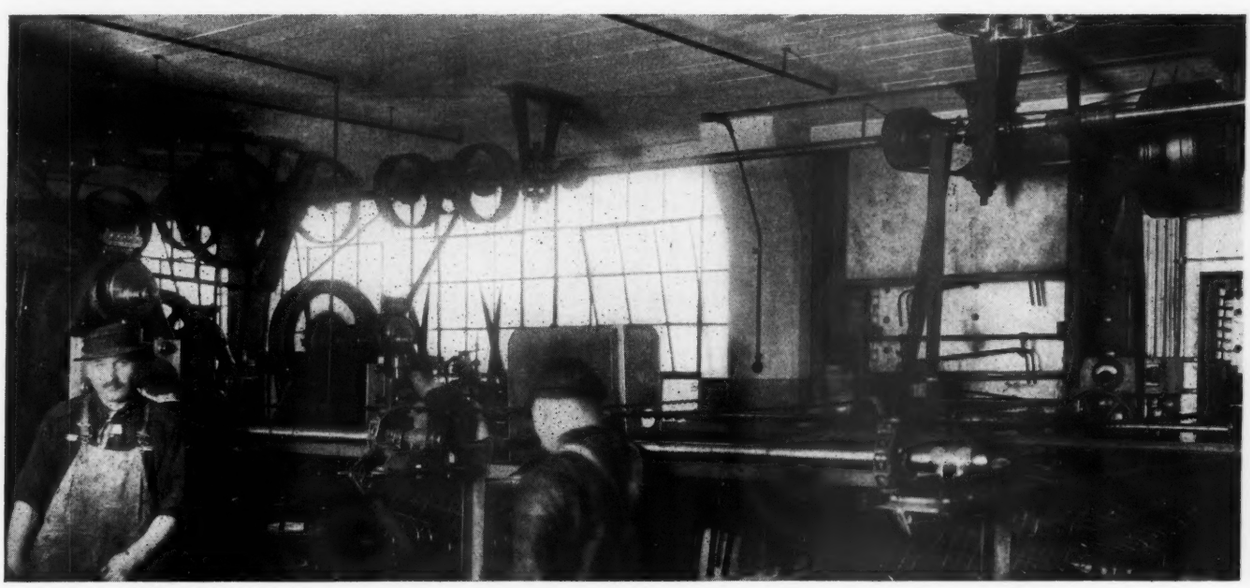


Fig. 4—A typical installation of the group shafting and belting system as discussed in the text.

Changing Motors from Two-Phase to Three-Phase

Procedure in regrouping the coils

By A. C. ROE

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DIRECTIONS were given in the preceding article, in the March issue, for making the checks that are necessary to determine the exact procedure that must be followed in changing a given motor from two-phase to three-phase. We can now consider the problems encountered in doing the work. The first problem in regrouping any two-phase winding for three-phase operation is the number of coils per group and their arrangement, when some groups have more coils than others. The tables given in the book "Repair Shop Diagrams" by Braymer and Roe, McGraw-Hill Book Company, will take care of any case and the diagrams can also be used for reconnecting.

Consider a four-pole, two-phase winding having 24 coils in eight groups, with three coils per group. The coils at the beginning and ending of each group have additional phase insulation and it is desired to regroup the winding for four poles, three-phase, or twelve groups of two coils each.

In Fig. 1, diagram *A* shows the 24 coils grouped for two-phase, three coils per group. Straight lines are used to represent the coils; the dark lines indicate the phase coils and their location.

Fig. *1B* shows the same winding regrouped for three-phase, with twelve groups of two coils each. At the points marked *1* there is one phase coil between adjacent pole-phase groups, and at the points marked *2* there are two phase coils.

The winding in Fig. 1 would be satisfactory to regroup for three-phase, as all groups are reinforced where the phases change by at least one coil with extra phase insulation which is suitable for low-voltage work (110 to 600 volts).

In reconnecting such a winding, cut off all leads and open all jumpers in the center. Then start at any one group and open the stub connection as at *X*, Fig. *1A* and join together *B* and *E* of groups *1* and *2*. Open the stub connection between coils *4* and *5*, marked *X* in Fig. *1A*. Thus, two two-phase groups are changed over to three three-phase groups; this is repeated for the remainder of the winding. Now we can formulate the following rule:

Any two-phase, two-layer windings having three coils in all groups and phase insulation at the beginning and ending of each group can be regrouped for three-phase, two coils per group, and have satisfactory phase insulation if arranged as Fig. 1 shows.

Consider a four-pole, two-phase motor having 48 coils, with eight groups of six coils per group, two phase coils per group. The three-phase, four-pole winding would have twelve groups of four coils per group. Fig. *2A, B,* and *C* shows how

TABLE I—110-VOLT TWO-PHASE TO 110, 220, 440 AND 550 VOLTS THREE PHASE.

Original Two-Phase Connection	3 Phase, 110 Volts		3 Phase, 220 Volts		3 Phase, 440 Volts		3 Phase, 550 Volts	
	Star	Delta	Star	Delta	Star	Delta	Star	Delta
Series	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.
2 Par.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.
3 Par.	4 Par.	2 Par.	2 Par.	Series	Rew.	Rew.	Rew.	Rew.
4 Par.	Rew.	3 Par.	Rew.	Rew.	Rew.	Rew.	Series	Rew.
5 Par.	6 Par.	3 Par.	3 Par.	Rew.	Rew.	Rew.	Rew.	Rew.
6 Par.	8 Par.	4 Par.	4 Par.	2 Par.	2 Par.	Series	Rew.	Rew.
7 Par.	Rew.	Rew.	4 Par.	Rew.	Rew.	Rew.	Rew.	Series
8 Par.	10 Par.	6 Par.	5 Par.	3 Par.	Rew.	Rew.	2 Par.	Rew.
10 Par.	Rew.	Rew.	6 Par.	Rew.	3 Par.	Rew.	Rew.	Rew.
12 Par.	Rew.	8 Par.	8 Par.	4 Par.	4 Par.	2 Par.	3 Par.	Rew.
14 Par.	Rew.	Rew.	Rew.	Rew.	4 Par.	Rew.	Rew.	2 Par.

Rew. = Rewind.

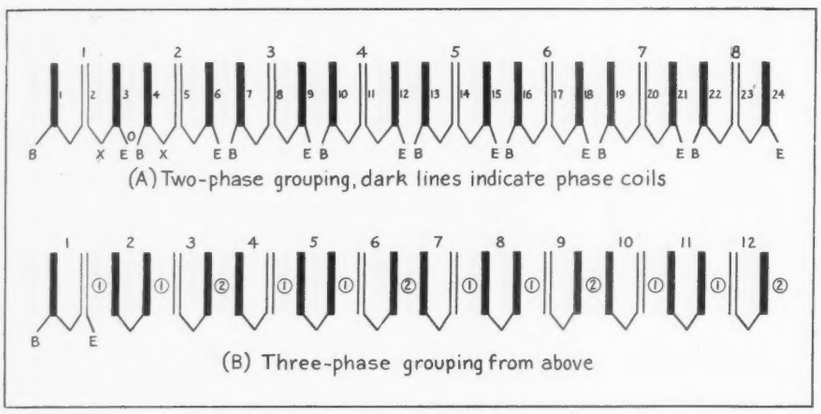


Fig. 1—How a two-phase winding (diagram *A*) can be regrouped for three-phase is shown in diagram *B*. The dark lines indicate the phase coils.

the original phase insulation can be used for the three-phase grouping.

Fig. *2A* shows parts of the two-phase winding arranged in proper grouping, whereas Fig. *2B* shows the best arrangement for the three-phase grouping. Note that in this case the new grouping has been started so that two phase coils are at the start of the three-phase group, with the result that at four points marked *X*, Fig. *2B*, extra phase insulation is necessary, but between eight groups we have one phase coil. The other four points can be taken care of as will be explained later.

Fig. *2C* shows the phase protection resulting from starting the new grouping at the beginning of a two-phase group. In this case there will be eight points without any phase insulation and four points with two phase coils.

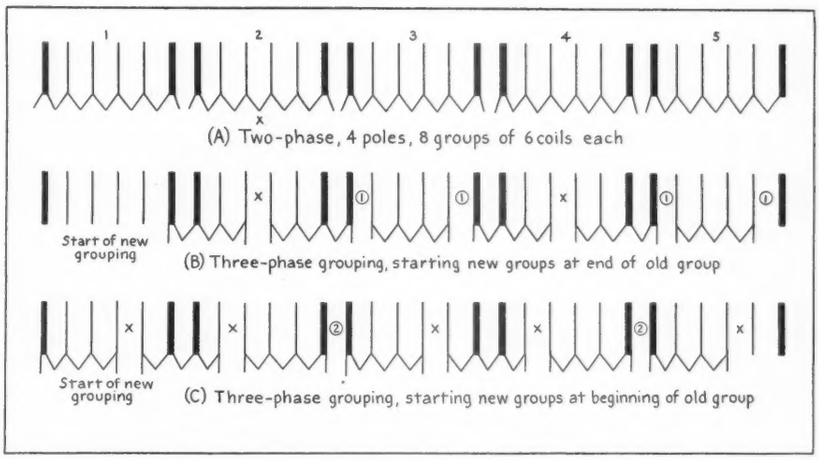

1
2
3
4
5
X
(A) Two-phase, 4 poles, 8 groups of 6 coils each
Start of new grouping
(B) Three-phase grouping, starting new groups at end of old group
Start of new grouping
(C) Three-phase grouping, starting new groups at beginning of old group

Fig. 2—Original grouping of two-phase winding, *A*, with, *B*, the best method of regrouping the coils for three-phase operation—by starting the new group at the end of the old group. Diagram *C* shows the phase protection that results from starting the new group at the beginning of the old group.

TABLE II—220-VOLT TWO-PHASE TO 110, 220, 440, AND 550 VOLTS THREE-PHASE.

Original Two-Phase Connection	3 Phase, 110 Volts		3 Phase, 220 Volts		3 Phase, 440 Volts		3 Phase, 550 Volts	
	Star	Delta	Star	Delta	Star	Delta	Star	Delta
Series	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.
2 Par.	Rew.	3 Par.	Rew.	Rew.	Rew.	Rew.	Series	Rew.
3 Par.	8 Par.	4 Par.	4 Par.	2 Par.	2 Par.	Series	Rew.	Rew.
4 Par.	10 Par.	6 Par.	5 Par.	3 Par.	Rew.	Rew.	Series	Rew.
5 Par.	Rew.	Rew.	6 Par.	Rew.	3 Par.	Rew.	Rew.	Rew.
6 Par.	Rew.	8 Par.	8 Par.	4 Par.	4 Par.	2 Par.	3 Par.	Rew.
7 Par.	Rew.	Rew.	Rew.	Rew.	4 Par.	Rew.	Rew.	2 Par.
8 Par.	20 Par.	12 Par.	10 Par.	6 Par.	5 Par.	3 Par.	4 Par.	Rew.
10 Par.	Rew.	Rew.	Rew.	Rew.	6 Par.	Rew.	5 Par.	3 Par.
12 Par.	Rew.	Rew.	Rew.	8 Par.	8 Par.	4 Par.	6 Par.	Rew.
14 Par.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	7 Par.	4 Par.

Note: If the connection indicated for three-phase is not possible with the number of poles, rewind.

From the above two examples it is obvious that a study of each case will reveal a method of using the maximum amount of the original phase insulation.

When the original two-phase winding or resulting three-phase grouping has an odd number of coils per group—that is, some groups have one coil more than others—the problems of phase insulation will require greater attention.

When regrouping a two-phase winding for three-phase, in which there are some groups without phase insulation, as in Fig. *2B* and *C*, some triangular pieces of treated cloth can be inserted to provide satisfactory phase insulation.

Reconnecting for Three-Phase

There are about six methods of changing a two-phase motor to operate on three-phase, but for a permanent change, there are only two alternative methods: (*1*) Reconnecting when all the two-phase turns and copper can be used, and when there is satisfactory phase insulation between adjacent pole-phase groups. (*2*) Rewinding with the correct proportions of turns and cross-sectional area of copper.

Let us consider the five reconnecting methods.

1. If we have a two-phase motor, we can, without any change in the winding, simply attach the ingoing lead of one phase and the outgoing lead of the other phase to one three-phase line, and the remaining two leads of the motor to the two remaining three-phase line leads. This type of connection gives reduced rating, and lower starting and pull-out torques. It is not to be recommended except for temporary or emergency cases.

2. This method involves cutting out approximately 20 per cent of the coils or turns in the two-phase winding, and regrouping and reconnecting the winding for three-phase. The change is based on the fact that a two-phase motor has approximately 25 per cent more turns than a corresponding three-phase winding. The main objection to this method is that the horsepower rating of the three-phase winding is reduced to approximately 87 per cent of the two-phase rating. This method is not recommended for permanent installations.

3. A two-phase winding can be reconnected without cutting out the excess turns. The resulting winding will give the effect of a normal three-phase motor operating on 80 per cent of full line voltage; the starting, full-load, and pull-out torques will be reduced, and the heating increased. This method is not recommended for permanent installations.

4. This method consists of making the T or Scott connection in the motor winding. It has the objection that the full-load power factor and efficiency are reduced, the starting and maximum torques are reduced, and the stator and rotor copper heating will be increased. Thus, the Scott connection is satisfactory for temporary changes, but is not recommended for permanent installations.

5. With this method all of the two-phase winding turns and copper are active in the resulting three-phase winding. It will be discussed in detail, using tables to indicate when a two-phase winding can be reconnected and use all of the copper and turns, the phase insulation being the deciding factor.

Tables I to IV indicate a number of reconnections possible for low-

voltage lap windings—110 to 550 volts inclusive. These tables will cover the majority of cases.

Do not attempt to reconnect any winding in the low-voltage class (110 to 550 volts) for 1,100- or 2,300-volt, three-phase operation: the insulation used throughout the low-voltage winding is not suitable for the higher voltages.

Table I lists eleven two-phase connections in the first vertical column; the connections listed in this column in all the tables are those existing in any original two-phase winding. In the succeeding columns are given the possible three-phase star or delta connections for 110, 220, 440 or 550 volts, using all of the copper and turns.

The first two lines in Table I indicate that when any 110-volt, two-phase motor has either a series or two-parallel connection, it cannot be reconnected for three-phase, 110, 220, 440, or 550 volts, but must be rewound. If the 110-volt, two-phase winding has a three-parallel connection, the third line of Table I indicates that it can be reconnected for 110 or 220 volts, three-phase, but must be rewound if a three-phase, 440- or 550-volt winding is desired.

Likewise, Table II indicates that any 220-volt, two-phase motor with a series connection must be rewound for 110, 220, 440, or 550 volts.

Tables III and IV show that a series two-phase motor can be reconnected for 440 or 550 volts.

Table V lists all of the connections possible on any two- or three-phase motor with any number of poles up to and including 42 poles. Thus, on a 36-pole motor there are nine possible connections.

When using the tables for checking the possible reconnections for three-phase, Table V must be consulted to determine whether the desired three-phase connection is possible on a motor under consideration.

Tables VI and VII list the possible reconnections from 1,100 or 2,200 volts two-phase to 1,100 or 2,200 volts three-phase.

The tables are based on using all the turns and giving a voltage within 10 per cent of normal. For checking cases not covered by the tables formulas are given below.

The first step in checking the possibilities of reconnecting any two-phase winding is to reduce the two-phase winding to a series-connected voltage and then check for a three-phase star or delta, series connection.

This can be done with two formulas: Formula 1 is, Two-phase to three-phase series star equals $C\ V\ 1.225$, where C equals the number of circuits in the original two-phase winding—C equals *1* for a series connection, *2* for a two-parallel, *3* for three-parallel, etc.—and V equals the two-phase motor line voltage with the original connection. Considering a two-phase, 220-volt motor that has a four-parallel connection, C equals 4 and V equals 220, in this case.

Formula 1 gives the line voltage for a series-star connection using all the two-phase turns; if a three-phase connection cannot be selected that

TABLE III—440 VOLTS TWO-PHASE TO 110, 220, 440, 550 VOLTS THREE-PHASE.

Original Two-Phase Connection	3 Phase, 110 Volts		3 Phase, 220 Volts		3 Phase, 440 Volts		3 Phase, 550 Volts	
	Star	Delta	Star	Delta	Star	Delta	Star*	Delta
Series	5 Par.	3 Par.	Rew.	Rew.	Rew.	Rew.	Series	Rew.
2 Par.	10 Par.	6 Par.	5 Par.	3 Par.	Rew.	Rew.	2 Par.	Rew.
3 Par.	Rew.	8 Par.	8 Par.	4 Par.	4 Par.	2 Par.	3 Par.	Rew.
4 Par.	20 Par.	12 Par.	10 Par.	6 Par.	5 Par.	3 Par.	4 Par.	Rew.
5 Par.	Rew.	Rew.	Rew.	Rew.	6 Par.	Rew.	5 Par.	Rew.
6 Par.	Rew.	Rew.	Rew.	8 Par.	Rew.	4 Par.	6 Par.	Rew.
7 Par.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	7 Par.	4 Par.
8 Par.	Rew.	24 Par.	Rew.	12 Par.	Rew.	6 Par.	8 Par.	Rew.
10 Par.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	10 Par.	Rew.
12 Par.	Rew.	Rew.	Rew.	Rew.	Rew.	8 Par.	12 Par.	Rew.
14 Par.	Rew.	Rew.	Rew.	Rew.	Rew.	Rew.	14 Par.	Rew.

*Note that a 440-volt, two-phase motor can be reconnected three-phase star (same number of circuits) for 550 volts.

* * *

TABLE IV—550 VOLTS TWO-PHASE TO 110, 220, 440, 550 VOLTS THREE-PHASE.

Original Two-Phase Connection	3 Phase, 110 Volts		3 Phase, 220 Volts		3 Phase, 440 Volts		3 Phase, 550 Volts	
	Star	Delta	Star	Delta	Star	Delta	Star	Delta
Series	6 Par.	Rew.	3 Par.	Rew.	Rew.	Rew.	Rew.	Rew.
2 Par.	12 Par.	7 Par.	6 Par.	Rew.	3 Par.	Rew.	Rew.	Rew.
3 Par.	18 Par.	10 Par.	9 Par.	5 Par.	Rew.	Rew.	Rew.	2 Par.
4 Par.	24 Par.	Rew.	12 Par.	7 Par.	6 Par.	Rew.	5 Par.	3 Par.
5 Par.	30 Par.	Rew.	15 Par.	Rew.	8 Par.	Rew.	6 Par.	Rew.
6 Par.	Rew.	Rew.	Rew.	10 Par.	10 Par.	5 Par.	8 Par.	4 Par.
7 Par.	Rew.	Rew.	21 Par.	Rew.	Rew.	6 Par.	Rew.	Rew.
8 Par.	Rew.	Rew.	24 Par.	Rew.	12 Par.	Rew.	10 Par.	6 Par.
10 Par.	Rew.	Rew.	Rew.	Rew.	15 Par.	Rew.	Rew.	Rew.
12 Par.	Rew.	Rew.	36 Par.	Rew.	18 Par.	Rew.	Rew.	6 Par.
14 Par.	Rew.	Rew.	42 Par.	Rew.	21 Par.	Rew.	Rew.	Rew.

* * *

TABLE V—CONNECTIONS POSSIBLE WITH MOTORS HAVING TWO TO FORTY-TWO POLES

No. Poles	Possible Number of Connections on Each Pole								
	1	2	3	4	5	6	7	8	9
2	Series	2 Par.							
4	Series	2 Par.	4 Par.						
6	Series	2 Par.	3 Par.	6 Par.					
8	Series	2 Par.	4 Par.	8 Par.					
10	Series	2 Par.	5 Par.	10 Par.					
12	Series	2 Par.	3 Par.	4 Par.	6 Par.	12 Par.			
14	Series	2 Par.	7 Par.	14 Par.	.....	.....			
16	Series	2 Par.	4 Par.	8 Par.	16 Par.	.....			
18	Series	2 Par.	3 Par.	6 Par.	9 Par.	18 Par.			
20	Series	2 Par.	4 Par.	5 Par.	10 Par.	20 Par.			
22	Series	2 Par.	11 Par.	22 Par.	.....	.....			
24	Series	2 Par.	3 Par.	4 Par.	6 Par.	8 Par.	12 Par.	24 Par.	
26	Series	2 Par.	13 Par.	26 Par.	.....	.....	.....	.....	
28	Series	2 Par.	4 Par.	7 Par.	14 Par.	28 Par.	.....	.....	
30	Series	2 Par.	3 Par.	5 Par.	6 Par.	10 Par.	15 Par.	30 Par.	
32	Series	2 Par.	4 Par.	8 Par.	16 Par.	32 Par.	.....	.....	
34	Series	2 Par.	17 Par.	34 Par.	.....	.....	.....	.....	
36	Series	2 Par.	3 Par.	4 Par.	6 Par.	9 Par.	12 Par.	18 Par.	36 Par.
38	Series	2 Par.	19 Par.	38 Par.	.....	.....	.....	.....	.....
40	Series	2 Par.	4 Par.	5 Par.	8 Par.	10 Par.	20 Par.	40 Par.	.....
42	Series	2 Par.	6 Par.	7 Par.	14 Par.	21 Par.	42 Par.	.....	.....

will bring the voltage to within 10 per cent of that desired for three-phase, the motor should be rewound.

Formula 2: Two-phase to three-phase, series-delta, equals $C\ V\ 0.7$, where C and V have the same meaning as in Formula 1.

Consider a two-phase, 220-volt, eighteen-pole motor connected nine-parallel which is to be connected for three-phase, 220 volts. Table II does not list a nine-parallel connection for the original motor; so using Formula 1 we find that the series-star line voltage would have to be $C\ V\ 1.225$, or $9 \times 220 \times 1.225 = 2{,}425$ volts, and we want to operate it on 220 volts, three phase. Dividing 2,425 by 220, to find the possible connection, gives 11.02, or an eleven-parallel connection would give a line voltage of $2{,}425 \div 11 = 220.4$ volts. This would be satisfactory, if an eleven-parallel connection were possible, but Table V indicates that it cannot be had on an eighteen-pole motor.

Trying the delta connection formula, we find the line voltage should be $C\ V\ 0.7$, or $9 \times 220 \times 0.7 = 1{,}386$ volts. Then, $1{,}386 \div 220 = 6.3$, or a six-parallel connection would result in a line voltage of $1{,}386 \div 6 = 231$, which is only 5 per cent higher than required and would be satisfactory. Inasmuch as Table V lists a six-parallel connection on eighteen poles, the above motor could be reconnected six-parallel delta for three-phase, 220 volts, if the grouping and phase insulation could be taken care of satisfactorily.

When a machine must be rewound, the first step in figuring the new three-phase winding is to convert the two-phase, series-connection winding into the three-phase line voltage, both star and delta series connections and using all of the two-phase winding turns, by means of Formulas 1 and 2 previously given.

The next step is to reduce the turns in the winding under consideration to a number that will give the required line voltage, or a voltage that will enable a connection to be used to obtain the desired line voltage for three-phase operation. When the number of turns is changed the cross-sectional area of copper must also be changed in the opposite direction: that is, if the total turns are increased the copper size should be decreased, and vice versa.

The following formulas can be used to determine the number of turns per phase for the new three-phase winding, at the desired operating voltage. Formula 3 is, Three-phase turns, T, equals $VO \div F$, where V is the desired three-phase line voltage, F the resulting three-phase line voltage found by Formulas 1 and 2, and O is the turns per phase in the old two-phase winding. Note that in Formula 3 turns per coil can be used instead of turns per phase.

Next, the size of copper must be determined when the turns have been altered, and for this use Formula 4: $A = OS \div T$, where A, area in circular mils or square inches of the new, three-phase conductor, S, is the area in circ. mils or square inches of the two-phase winding conductor, and O has the same meaning as in Formula 3 above.

Be sure to use the same term for cross-sectional area consistently.

The simplest and easiest method of attacking a two- to three-phase change is, first, check the condition of the winding and its type of phase insulation. Then reduce the two-phase winding to three-phase line voltage, both series star and delta. Next, try to reduce this voltage to the desired three-phase line voltage by trying the different numbers of parallel connections possible for the number of poles in the winding under consideration, as given in Table V. Then if the voltage is too high or too low, use Formulas 3 and 4 to obtain the correct winding for the three-phase voltage.

The arrangement of the wires and size and type of conductor will be governed in each case by the slot and end room available. The revised edition of A. M. Dudley's book "Reconnecting Induction Motors," will enable one to handle any changeover.

The rotors of slipring or squirrel-cage type motors will not require altering, regardless of whether the stator is rewound or reconnected, if the speed or number of poles is not changed.

Hoist Manufacturers Hold Annual Meeting

OFFICERS for the coming year were elected at the thirteenth annual meeting of the Electric Hoist Manufacturers Association, which was held March 20, Pittsburgh, Pa. J. G. Worker, American Engineering Company, Philadelphia, Pa., was elected chairman, and D. S. Brisbin, Chisholm-Moore Hoist Corporation, Tonawanda, N. Y., became vice-chairman.

Coffin Awards to General Electric Employees

Thirty-seven employees of the General Electric Company, who during 1929 saved money for the company or contributed to its efficiency in an unusual degree have been given awards under the Charles A. Coffin Foundation. The award in each case consists of a certificate of merit and a substantial sum of money. Many of the suggestions mean a definite annual saving to the company.

TABLE VI—1,100 VOLTS TWO-PHASE TO 1,100—2,200 VOLTS THREE-PHASE

Original Two-Phase Connection	3 Phase, 1,100 Volts		3 Phase, 2,200 Volts	
	Star	Delta	Star	Delta
Series	Rew.	Rew.	Rew.	Rew.
2 Par.	Rew.	Rew.	Rew.	Rew.
3 Par.	4 Par.	2 Par.	2 Par.	Series
4 Par.	Rew.	3 Par.	Rew.	Rew.
5 Par.	6 Par.	3 Par.	3 Par.	Rew.
6 Par.	8 Par.	4 Par.	4 Par.	2 Par.
7 Par.	Rew.	Rew.	4 Par.	Rew.
8 Par.	10 Par.	6 Par.	5 Par.	3 Par.
10 Par.	Rew.	Rew.	6 Par.	Rew.
12 Par.	Rew.	8 Par.	8 Par.	4 Par.
14 Par.	Rew.	Rew.	Rew.	Rew.

TABLE VII—2,200 VOLTS TWO-PHASE TO 1,100—2,200 VOLTS THREE-PHASE

Original Two-Phase Connection	3 Phase, 1,100 Volts		3 Phase, 2,200 Volts	
	Star	Delta	Star	Delta
Series	Rew.	Rew.	Rew.	Rew.
2 Par.	Rew.	3 Par.	Rew.	Rew.
3 Par.	8 Par.	4 Par.	4 Par.	2 Par.
4 Par.	10 Par.	6 Par.	5 Par.	3 Par.
5 Par.	Rew.	Rew.	6 Par.	Rew.
6 Par.	Rew.	8 Par.	8 Par.	4 Par.
7 Par.	Rew.	Rew.	Rew.	Rew.
8 Par.	20 Par.	12 Par.	10 Par.	6 Par.
10 Par.	Rew.	Rew.	Rew.	Rew.
12 Par.	Rew.	Rew.	Rew.	8 Par.
14 Par.	Rew.	Rew.	Rew.	Rew.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices which are designed to improve plant operation or reduce operating and maintenance costs.

Lee Direct Hot-Air Heating System

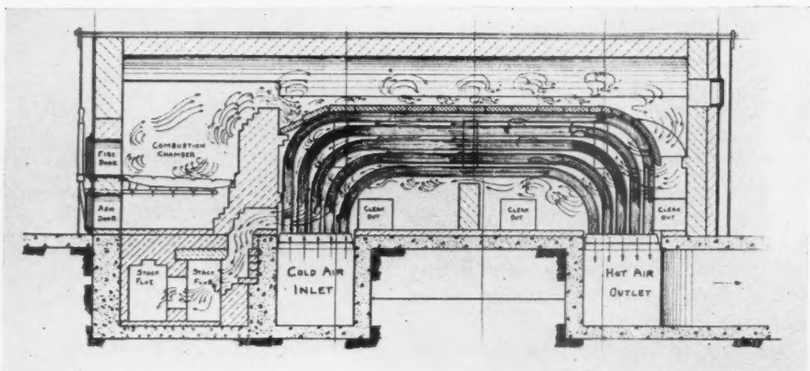
ANNOUNCEMENT has been made of the development by the Lee Air Heater Company, Youngstown, Ohio, of a heating system with fan circulation of warm air through ducts, for the purpose of heating large industrial buildings by means of warm air. The furnaces are of a distinct design, modified from the well-known steel plant recuperator, and are constructed to withstand heavy firing.

A feature of the heater is the forced circulation of the air through the tubes of the furnace, providing efficient cooling and preventing burning of the metal at high rating.

Uniform distribution of the warm air to every part of the building is secured by a system of underground or overhead ducts. The air fan is driven by a variable-speed motor, and on the same shaft is a smaller fan to provide induced draft for the furnace.

This system, it is stated, offers several advantages over the conventional steam heating system. Distribution of heat starts as soon as the fire is lighted, and it is unnecessary to maintain a banked fire in order to keep up the steam pressure. In mild weather the fire may be allowed to go out in the afternoon, and the building made comfortable next morning by the use of kindling and a little coal. No maintenance is required beyond the occasional oiling of the fan bearings and such repairs as are needed by the grate and furnace.

The system is adaptable for use in garages, foundries, machine shops, and factory buildings of all types. Usually the heater is placed in a lean-to at the side of the building, or any other available location. Fans and ducts are available for ventilation in summer, and air-conditioning equipment can easily be added.



Section through the heater showing combustion chamber and the air-heating tubes with countercurrent passage of air and flue gases.

Brown Remote-Type Transmitting Pressure Gage

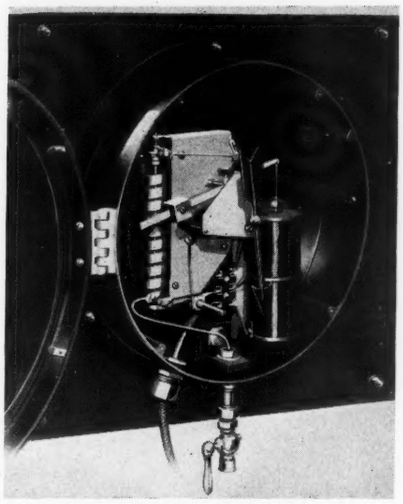
A REMOTE-TYPE pressure gage has been developed by the Brown Instrument Company, Philadelphia, Pa., for measuring distant pressures over a wide range. The self-balancing inductance bridge is the basic principle upon which this model operates.

An accompanying illustration shows the interior arrangement of the pressure transmitter.

These helix-type instruments are used to transmit pressure readings where the maximum pressure will be between 50 and 5,000 lb. per sq. in., and where changes in liquid level may be transmitted by fluctuations in an equivalent pressure of 50 lb. or more. For pressures lower than 50 lb. maximum, the manometer transmitter is used.

All instruments in this group are provided with a specially designed hollow helix which expands or contracts with pressure changes. The motion of the helix actuates an armature inside an inductance coil, the movement of the

Overhead-duct system with outlets brought down along the wall.



armature being transmitted and duplicated in the receiving meter, where it is converted into accurate indications of the changes in pressure or liquid level affecting the helix.

Alternating current is used without the use of voltage regulators or compensators. The gages are unaffected by voltage fluctuations within normal limits. These instruments are available in indicating and non-indicating types.

Reed, Midwest, and National Air Filter Companies Unite

ANNOUNCEMENT has been made of the consolidation of the Reed Air Filter Company, Midwest Manufacturing Company, and the National Air Filter Company, forming the American Air Filter Company, Inc., with headquarters at First and Central Ave., Louisville, Kentucky.

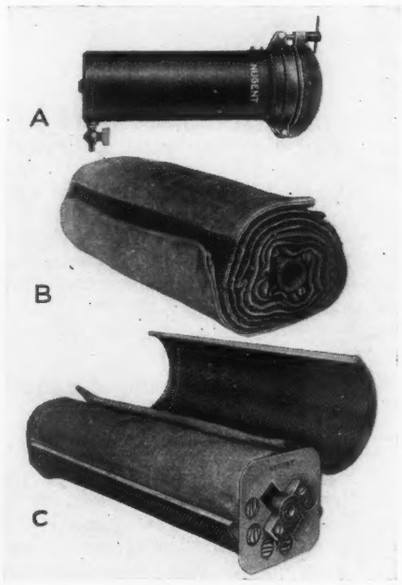
Nugent Automatic Bypass-Pressure Oil Filter

A SMALL compact pressure filter, with large capacity for the space occupied, has been designed by William W. Nugent & Company, 410 North Hermitage Ave., Chicago, Ill., for purifying fuel and lubricating oils used with Diesel engines, hoists, gear drives, large bearings, hydraulic turbines, ammonia and air compressors, pumps and other machinery of a similar character. The filter will withstand working pressure of 100 lb., is not affected by vibration, and may be set horizontally, vertically, or at an angle anywhere in the discharge line between the pump and the bearings to be lubricated. Clamps are available to mount the filter on engine frame, wall or bracket, or it may be immersed in a special oil tank.

An important feature of its operation is automatic bypassing of the full supply of oil to the engine or machine when the pressure drop through the filter rises to a predetermined point, as for example, when cleaning has been neglected. For a continuous supply of pure oil, duplicate units are recommended.

The view at *A* shows a typical exterior of the filter with the inlet at the bottom and the hinged cover at the top, which may be opened readily to remove the filtering elements for cleaning. For fuel oil or lubricating oil containing water, the outlet is near the top, and a petcock is placed near the bottom of the case, through which entrained water is blown off.

Views *B* and *C* show the filtering equipment consisting of four filtering elements (bags of different grades and density of fabric to suit the viscosity of the oil), which are fastened to four projecting oil nozzles on a central distributing spool through which the oil is forced into the bags. In order that the oil may reach all available filtering surface, wire-spacing mats are placed between adjacent bags, and the filtering elements, also, mats are rolled around the distributing spool. A hinged-wire cage container keeps the bags in place; facilitates their handling, and provides a space between the filtering cartridge and the wall of the casing through



which the purified oil may flow to the outlet. View *C* shows this cage.

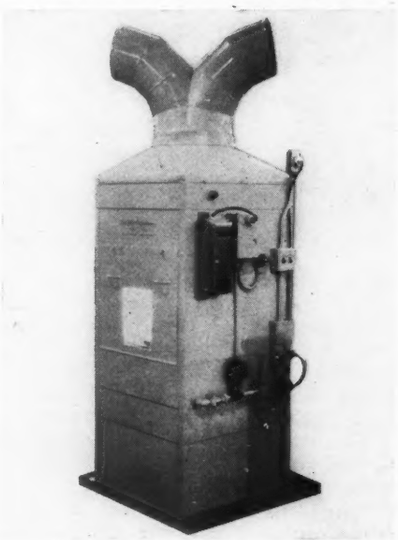
These filters are made in three different sizes; for pressure drops of 3, 10, and 15 lb., and in capacities ranging from 86 to 4,637 g.p.h., dependent upon the pressure drop and the viscosity of the oil.

Parks-Cramer Type NCH Unit Air Conditioner

A UNIT air conditioner of compact design, designated Type NCH, has been introduced recently by Parks-Cramer Company, Fitchburg, Mass. This unit was designed for humidifying laboratories, testing rooms, conditioning rooms, small manufacturing spaces, and offices.

It is of the centrifugal type, handling 15 cu. ft. of air per min. and evaporating up to 4 gal. of water per hour. Water is thrown off by a rapidly revolving disk in a very fine spray and circulated through the room by a multi-blade fan mounted on the same shaft as the disk. All the water consumed is evaporated. Eliminator plates remove all the free moisture, allowing only the saturated air to pass through.

If desired, the unit can be furnished with an immersion heater, thermosta-

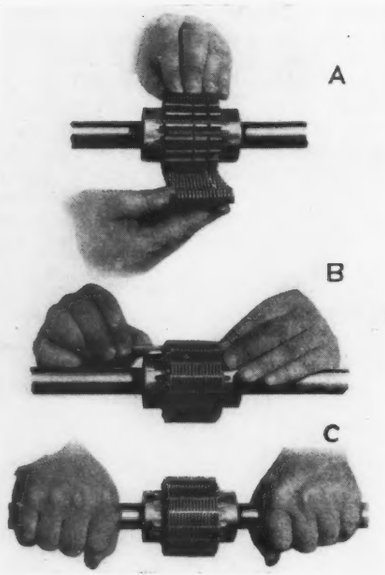


tically controlled to hold the water at any desired temperature. In this device the air, after passing through the humidifying chamber, is warmed by an extended surface heater also thermostatically controlled by a sensitive element placed anywhere in the room. Likewise, if it is wished to control the humidity of the air, the conditioner can be fitted with the Park-Spray hygrostat.

Morse Flexible Couplings

THE feature of the flexible couplings announced by the Morse Chain Company, Ithaca, N. Y., is that they consist of two sprockets encircled by a Morse silent chain. This chain is held in place by a guide groove in one sprocket, while the other sprocket is free to float under the chain. The full floating principle employed relieves the adjacent shaft bearings of possible thrust strains by permitting freedom of end play. In addition, the flexibility of the chain relieves the coupling pinions of a great deal of the shock and binding that accompanies starting, and consequently reduces excessive wear on the coupling parts.

Inaccuracies of alignment of the connected shafts are taken care of by the flexibility of the chain. Small clearances between the pins and the links, and between the links themselves, permit sliding of the links relative to each other. Also, relative motion is possible between the sprockets and the



chain, which is self-centering due to centrifugal force. Some couplings have shearing pins to prevent overloading of the machine. Other combinations of couplings with clutches, clamp hubs, and spring sprockets have been worked out for special cases.

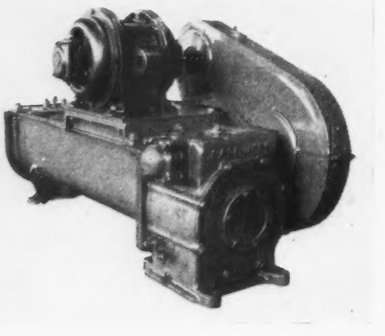
There is shown a coupling without the oil-retaining, spun-metal cover to illustrate the steps in assembly. The coupling is frequently run without the cover. In the usual installation of this spun-metal case, it is separated from the chain by a layer of felt whose purpose is to hold oil and to insure silent operation. The metal case is self-centering and requires no bolts nor machine screws. When the coupling is used in hot, wet, or gritty atmospheres, these cases are especially recommended to prolong the life of the coupling.

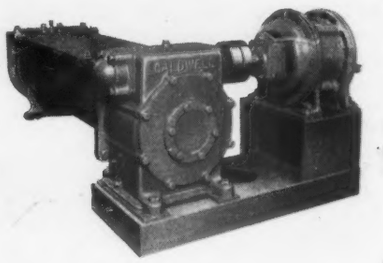
Caldwell Standardized Drives for Screw Conveyors

PURSUANT with its plan to standardize various driving mediums, H. W. Caldwell & Son Company, Chicago, through the Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill., announce its standardized drives for screw conveyors of from 8 to 16 in. in diameter.

These screw-conveyor drives are made in two arrangements, Type C and Type D. The former consists of two speed reductions from motor to screw conveyor, each through a power transmission medium—a Link-Belt silent chain drive fully enclosed in an oil-retaining steel casing, and worm-gear speed reducer, designed to serve as a thrust-end and screw-conveyor drive. The latter consists of a direct-coupled reducer, mounted with the motor on a unit base plate. This type of drive permits the selection of a worm-gear reducer according to horsepower rating, without regard to the size of the conveyor trough on which the drive is to be mounted.

All reducer bearings on both types are anti-friction, with automatic lubrication. Oversize Timken bearings on the worm-gear shaft take the conveyor end thrust in either direction. The standard drive is adaptable to horizontal or inclined conveyors, with proper adjustment of oil levels.





Standard motors with speeds of 860, 1,160, 710 or 1,430 r.p.m., can be accommodated on these conveyor drives, which provide a range of conveyor speeds from 45 to 125 revolutions per minute.

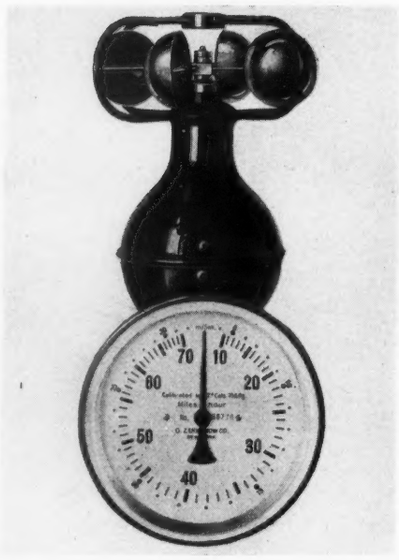
Shaffer Oil & Refining Changes Name

ANNOUNCEMENT has been made of the change of name of the Shaffer Oil and Refining Company to the Deep Rock Oil Corporation. Headquarters of the company are maintained in Tulsa, Okla. The corporation will continue as a unit of the Standard Gas and Electric Company system.

Zernickow Anemo Tachometer

DESIGNED to provide a convenient means of ascertaining the capacities of fans, compressors, blowers and similar equipment, the anemo tachometer or air velocity meter, illustrated, combines a Robinson cup-cross and a centrifugal-type tachometer.

Where exposed to an air current the cup cross receives a definite average angle velocity in such a manner that the average absolute speed of the cup center is in approximately constant relation to the wind velocity. The rotation of the cup is transmitted through a ball-bearing spindle to the hand of the instrument, which has



double graduation from 10 to 70 miles per hour and 5 to 35 meters per second.

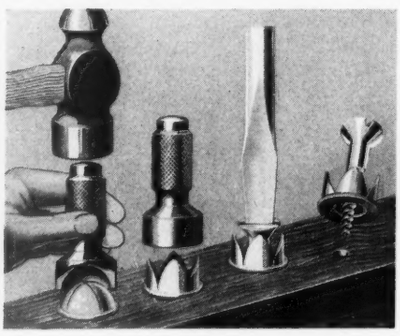
It is claimed by the manufacturer that for the net result of measurements it is immaterial whether the suction or pressure conduit is tested or whether the air current is laminary or turbulent.

The size of the dial is 4 in. and the net weight of the instrument is 2 lb. When inclosed in carrying case, which measures 4¾ in. wide, 4½ in. high and 10 in. long, the gross weight is 4 pounds.

Rawplug "Crowners" and "Lok-Crowners" for Concealing Screw Heads

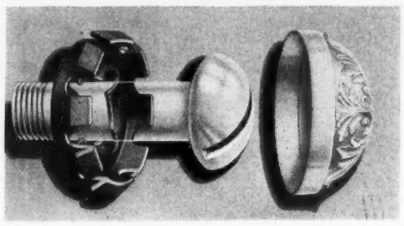
UNSIGHTLY screw heads, bolt heads, and nuts may be covered neatly with a suitable "Crowner" or "Lok-Crowner," both of which are small ornamental caps. The former are used principally to enhance the appearance of the product, whereas the latter, in addition to this feature, are capable of preventing loosening because of a special lockwasher construction. These specialties have been placed on the market by the Rawlplug Company, Inc., 66 West Broadway, New York City.

Crowners, in addition to concealing the heads of exposed screws, permit the use of stronger and less expensive iron screws to replace brass, bronze and specially plated screws. They prevent



tampering with screws and easy removal of fixtures and devices, and reduce the cost of assembling products by simplifying the design. As will be seen in the one view, they can be applied quickly. They eliminate torn garments and injuries caused by burred screw slots. The cap will not rust and may be made to match any finish desired. It is available for every size screw, bolt, and nut.

As shown in the other view, the Lok-Crowner combines all the features of the Crowner and prevents the loosening of nuts from vibration, being provided with a special lockwasher.



Westinghouse Photo-Electric Cell and Amplifier Unit

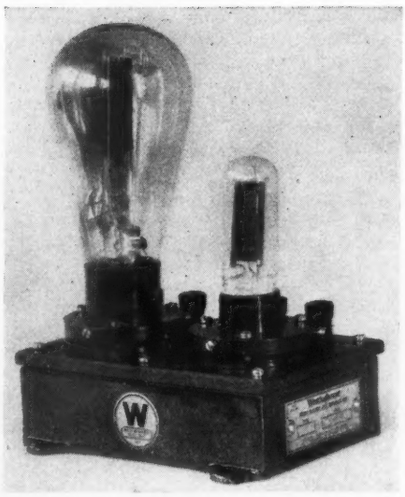
A PHOTO-ELECTRIC cell with an amplifier is now being marketed as a unit by the Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa. The photo-electric cell, often called the "electric eye," is a light-sensitive device. When light falls upon it, voltage having been applied to the cathode, a current passes by means of electron emission from the cathode to the anode. This current is very small, but, when amplified, operates commercial relays.

For some applications, complete apparatus has been developed and can be supplied as a unit; but for most applications where no stardard apparatus is available, the photo-electric cell with its amplifier is handled as a self-contained unit to be applied by the customer.

The amplifier unit, shown in the illustration, consists of a die-cast aluminum box in which are mounted the necessary coupling devices. The top, which is a Micarta panel, is provided with two four-prong bases for mounting the photo-electric cell and the amplifier tube. All of the wiring is concealed, connections being made to binding posts on the top panel. The unit is dust-proof and moisture-proof. Short connections in the unit make possible a very high speed response—between 0.0001 and 0.001 seconds.

Although four prongs are supplied in the photo cell for mounting in a standard four-prong base, only two are connected — the anode and cathode prongs. The cathode plate is coated with Caesium.

This device is applicable to tasks now requiring tiresome watching by the human eye. Some of the many applications are: sorting materials, according to color, size, and shape; counting items, where mass production



requires speed; initiating operations, such as ringing an alarm on a paper machine when a break occurs in the paper; lighting control, for turning on and off artificial lights according to the intensity of the natural light; position indicator, for showing positions of doors, moving cars, etc.; light intensity meter, for measuring intensity of light for photography; scanning material, to detect flaws or defects.

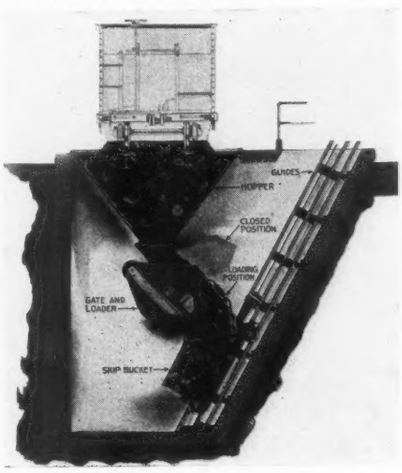
The Ohio Electric & Controller Company Changes Name

AT the annual meeting of shareholders held March 14th, 1930, the name, "The Ohio Electric Manufacturing Company," was adopted in place of the former name, "The Ohio Electric & Controller Company."

Link-Belt Automatic Loader for Skip Hoists

LINK-BELT COMPANY, Philadelphia, Pa., announces the addition of an automatic loader to its line for the proper loading of skip-hoist buckets.

This loader, known as the Full-Bucket-Control Type, has a simple attachment, which consists of a swinging plate so arranged that unless material is flowing through the chute in sufficient depth to maintain electrical contact, the skip hoist will not operate. In other words, there has to be sufficient material in the hopper to fill the bucket.

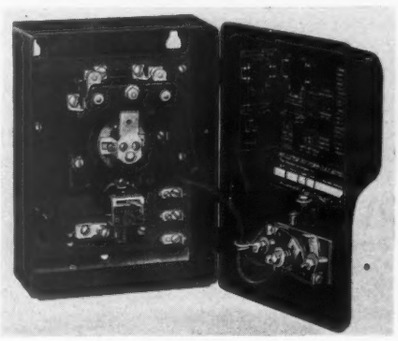


As the bucket reaches the loading position the loader permits the material to flow from the hopper until the bucket is full. Then the mechanism instantly causes the bucket to be hoisted, thereby moving the loader into its closed position, where it remains as the bucket continues to travel to the emptying point, and until it returns to the loading position where it is again automatically loaded.

The bucket continues to load and empty automatically so long as there is sufficient material to fill it.

Allen-Bradley Starting Switch for Single-Phase Motors

THE Allen-Bradley Company, 286 Greenfield Ave., Milwaukee, Wis., announce the development of a single-phase starting switch for motors operating refrigerating machines, com-

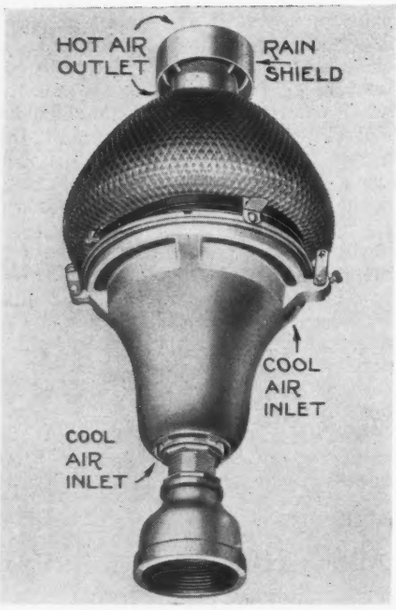


pressors, pumps, oil burners and other motor-driven devices governed by either two- or three-wire control.

It is a d.p. magnetic switch with thermal overload relay and rated, 1½ hp., 110 volts, and 3 hp., 220 volts. A feature of this starting switch is the operating coil which has a double winding for series-parallel connections permitting the switch to be used interchangeably up to and including 1½ hp. for 110- or 220-volt motors by simply changing the terminal connections of the operating coil. It can be furnished with start and stop pushbuttons in the cover, without pushbuttons, and with two-way lever switch.

Line Material Ventilated Lighting Fixture

AN externally adjusted substation lighting fixture with ventilating features has been announced by the Line Material Company, South Milwaukee, Wis. This unit has two cool air inlets and one hot air outlet. The cool air inlets are screened and arranged for giving an even distribution of air through the glassware, one path



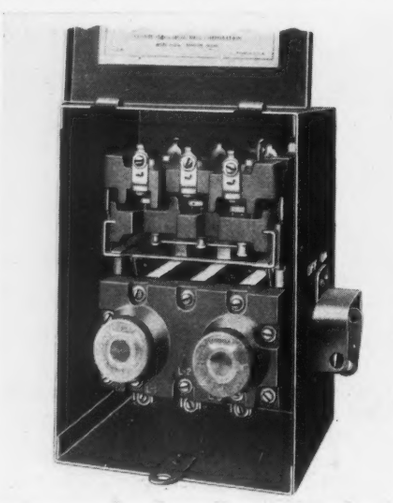
being between the outer glassware and refractor and the other path being between refractor and lamp. The unit is made for use with lamps of 300 watts and above; for lamps less than 300 watts the standard inclosed fixture can be used without special ventilating features.

Condit Type A-15 Air Motor Starter

A MANUALLY operated air motor starter, known as Type A-15, has been placed on the market by the Condit Electrical Manufacturing Corporation, Boston, Mass. This device embodies the principle of arc prevention based on contacts of such shape, mass, relation and arrangement with respect to voltage and energy to be absorbed as to reduce the visual evidence of circuit interruption to a spark of negligible importance, even under heavy overloads.

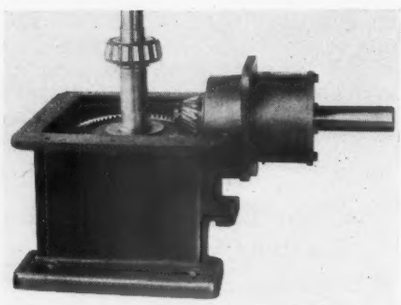
All starter contacts are assembled in units on insulated carrier bases; one stationary, the other movable. The movable contact base can be withdrawn without the use of tools permitting ready inspection of both movable and stationary contacts. The stationary and movable contacts are identical and interchangeable.

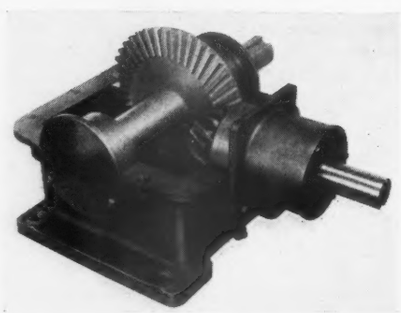
Thermal cutouts are provided for time-lag overload protection. The Type A-15 is furnished in ratings; 7½ hp. at 550 and 440 volts; 5 hp. at 220 volts, and 3 hp. at 110 volts.



James Spiral Bevel Gear, Right-Angle Speed Reducer

ANNOUNCEMENT has been made by the D. O. James Manufacturing Company, 114 W. Monroe St., Chicago, Ill., of the development of a line of right-angle speed reducers which consist of spiral bevel gears mounted on Timken roller bearings. This line includes both horizontal and vertical types with slow-speed shaft extended either upward or downward. Ratings range from ¼ to 100 hp. with ratios 1:1 to 6:1. Larger reductions are obtained by the combination of the spiral bevel gear and planetary spur gears with ratios 8:1 to 1600:1 or more. The gear teeth and bearings are lubricated by the splash system.

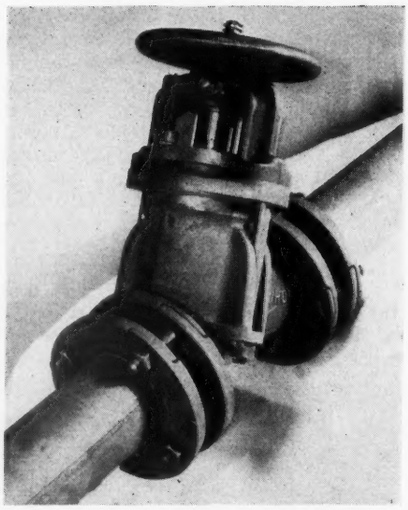




Duriron Y Valve

ACCOMPANYING illustrations show a Y valve which has been developed recently by the Duriron Company, Dayton, Ohio. All parts of the valve that come in contact with the liquid handled are made of Duriron.

Special features claimed for the valve include nearly straight flow and full opening; possibility of repacking the valve under pressure while in the closed position; extra long Duriron stem; gland bolts which bear against the top of the yoke and are not exposed to possible gland leaks.



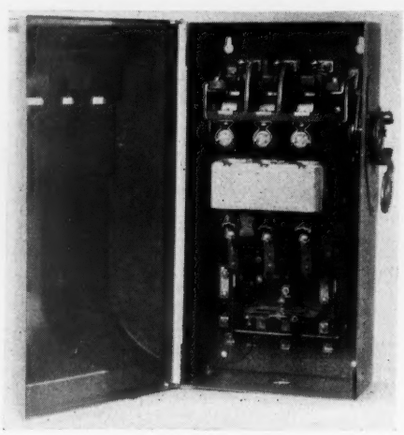
Other features claimed include an extra-deep stuffing box; a narrow valve seat which is said to reduce the possibility of the collection of particles on the seat; and reduction of sticking to the minimum. The valve is made in sizes from ¾ to 4 inches.

Westinghouse Combination Linestarter and Safety Switch

A COMBINATION linestarter and safety switch, designated Class 11-200-HD, is a recently developed product of the Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa. This apparatus occupies a minimum of space, being much more compact than a linestarter and a safety switch mounted in separate cabinets.

Provision has been made for inserting a plug-type meter test jack to determine the load on the machine, while the motor is in operation and while the door of the cabinet is closed.

The equipment can be used with or without fuses; jumpers are supplied for use when fuses are not used. It has quick-break contacts; the handle is interlocked with the cover, preventing opening when the contacts are closed.



Montgomery Combined Stop Watch and Speed Register

A COMBINATION stop watch and speed register is being marketed by Montgomery and Company, Inc., 292 Lafayette St., New York, N. Y. The counter and works of the watch have been combined so that they are simultaneously thrown in and out of gear. The driving spindle runs idle. When inserted in the center of the shaft of which the speed is to be ascertained the driving-spindle is also made to revolve, but does not start. Counter and stop watch will start simultaneously only by firmly pressing the instrument against the shaft. As soon as the pressure is relieved stop watch and counter stop and can be read at a glance.

To reset the watch the application of pressure on a small knob on the watch brings the dial back to zero, and

winds the watch for the next reading. The watch can be used as an ordinary stop watch. To reset the counter simply turn the knob once and you have zero position again.

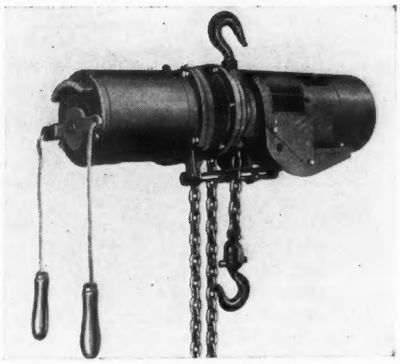
Standard Computing Dormant Scale

A DORMANT scale of simple and reliable design has been developed by the Standard Computing Scale Company, Detroit, Mich. Scale readings are indicated by a pointer on a dial by graduations of 1 lb. from 0 to 1,000 lb. A simple range-changing device makes it possible to increase the capacity to 2,000 or 3,000 pounds.

A locking device holds the platform when weighings are not being made, so as to preserve the sensitivity of the bearing surfaces. This scale is supplied with platforms in sizes from 36x48 to 48x72 inches.

Chisholm-Moore "Cyclone" Electric Hoist

DESIGNED for moving heavy and continuous loads, the "Cyclone" electric hoist recently developed by the Chisholm-Moore Hoist Corporation, division of Columbus McKinnon Chain Corporation, Tonawanda, N. Y., is available in ½- and 1-ton capacities, and with lifting speeds of 20 and 14 f.p.m. respectively.



This hoist is a spur-geared unit equipped with anti-friction bearings at each rotating point. The hoisting unit consists of the Cyclone hand-power chain hoist with slight alterations to make it suitable for motor driving. A built-in brake takes effect instantly when current is discontinued, thereby providing accurate control in raising or lowering load. When the hook reaches its highest or lowest position, a trip lever automatically stops the hoist by returning the controller arm to the neutral position.

Instead of flexible conductor cable a shoe-type collector can be supplied for attaching to a "Matchless" trolley, or a wheel-type collector can be furnished, if desired.

Lubrication is furnished by means of a grease bath. An oil-tight frame prevents grease from dripping on the material being handled.

"Durimit" Floor Surfacing Material

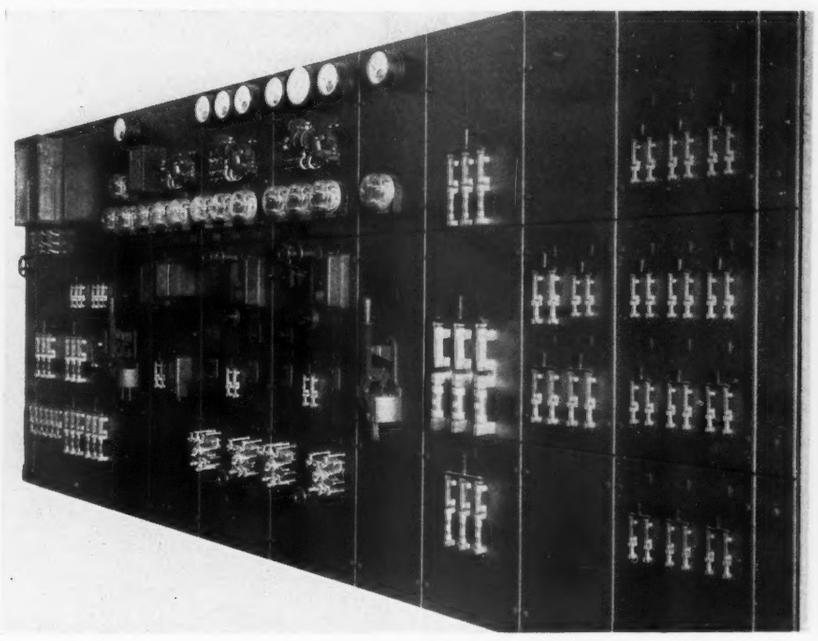
A HARD material that may be combined with cement to produce a tough, non-cracking floor surfacing has been announced by Durimit Floors, Inc., 27 E. Water St., Cincinnati, Ohio. This material, known as "Durimit," is composed of crystals and crystaloids, which according to the Mohs scale, are almost as hard as diamonds. It is said that this flooring will not check nor pit under the heaviest kind of traffic, and neither will it absorb oil or grease. Of further interest is the fact that it does not disintegrate upon heavy abuse, and therefore does not set free dust to menace high-grade machinery. It is also waterproof.

General Electric Switching Equipment for Emergency Engine-Driven Generator

GENERAL Electric Company, Schenectady, N. Y., announce the development of an automatic switching equipment for use when a.c. generators are direct connected to gasoline engines that are employed as an emergency power source. The equipment is mounted on panels of standard size and may form part of a switchboard which also takes care of power distribution. Either single- or double-unit equipments are available.

An automotive starting unit, that is energized from a storage battery which is kept charged by means of a tungar rectifier connected to the a.c. source, is provided for the engine. When the indication is given of the failure of the normal a.c. power supply the engine starts automatically and the generator is then connected to supply emergency power.

Upon return of the power to the preferred source the ignition system of the engine is interrupted to shut down the unit and the preferred line breaker is reclosed restoring normal operation. Standard safety features are included.



Universal Gear Speed Reducers

TWO British developments in power transmission equipment have recently been introduced into the United States by the Universal Gear Corporation, 327 S. LaSalle St., Chicago, Ill. The first is a fixed-ratio speed reducer known as the "Heliocentric," and the second, the "Revocentric," an infinitely

Fig. 1—Heliocentric Fixed-Ratio Speed Reducer.

variable speed reducer. The former, which has been in use in England since 1923, is shown in Fig. 1. It consists of a casing, around the inner periphery of which is an internal gear rack. Inside of this is a spool piece carrying a number of plungers which bear at their inner ends upon an eccentric. The eccentric is driven at the high speed of the motor and the construction of the apparatus is such that the spool piece, connected to the low-speed side, is driven at a reduced speed as the plungers are forced against the rack by the eccentric rotation.

This reducer has 25 plungers and 49 rack teeth. The angular distance through which the spool piece advances while the eccentric is turning through any given angle may be easily calculated. In this case it consists of the difference between the angular distance from one tooth to the second following, n, minus the angular distance between plungers, m. The ratio of the reducer is therefore

$$\frac{n-m}{n}$$

or in this case 50 to 1.

Reducers of this type are made for

Fig. 2—Revocentric Infinitely Variable Speed Reducer.

reduction of from 8 to 1 up to 60 to 1 and, by using two or more reducers in series, in ratios as high as one million to one. Sizes to transmit up to 50 hp. are available. These reducers are also built as an integral part of an electric motor.

The "Revocentric" reducer shown in Fig. 2 consists of an adjustable-throw eccentric on the input shaft, driving five clutches through toggle joints which are mounted between two disks on the output shaft.

Although it is not shown, the means for varying the throw of the eccentric is comparatively simple. By a handwheel or other method, the inner member of a hollow drive shaft is twisted with respect to the outer member by means of prongs which are keyed to the inner shaft and slide in helical slots in the outer. This movement causes the inner and outer eccentric members of the cam to turn with respect to each other and vary the eccentricity from zero to a maximum.

This reducer is infinitely variable in output speed from one-thirteenth of the input speed to zero. The speed may be varied while the gear is in motion and under load. It is available in sizes up to 15 horsepower.

Sumet "Sumetized" Bronze-Lined Steel-Backed Bearings

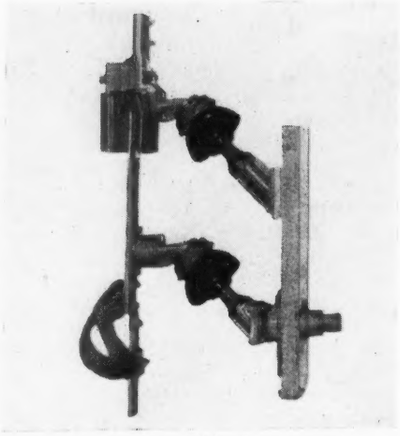
THE Sumet Corporation, Buffalo, N. Y., announced a line of bronze-lined and bonded bearings, and bearing materials under the name of "Sumetized." These steel-backed bearings are built up with a bronze liner intimately bonded to the steel. The bonded liner can be finished as thin as 1/62 in., and the bearings in any ordinary commercial diameter.

Sumetized bonded bronze is essentially a high-lead content bronze bearing with the tensile strength for a given wall thickness greatly increased by the steel back. The bond between the bronze and steel is claimed to be intimate so that no sliding or breaking off is possible.

Delta-Star GPM Form 1 Disconnecting Switch

A LINE of medium-duty, gang-operated disconnecting switches, known as GPM Form 1, is announced by the Delta-Star Electric Company, 2400 Block Fulton St., Chicago, Ill. The switch illustrated, is rated 7,500 volts, 1,200 amp. Its design provides for vertical mounting with 45-deg. insulators, insuring good-wiring conditions and high factors of safety as to flashover between upper and lower insulators with the switch in the open position.

Contacts are of the double, self-aligning, full-floating type. Flexible leads connect a hinged terminal with the blade of the switch. The hinged



terminal is located with respect to the rotating bearing on the switch base so that the conductor remains in a fixed position regardless of the swing of the lower insulator.

Switches of this type are especially adaptable for use as oil-switch disconnects.

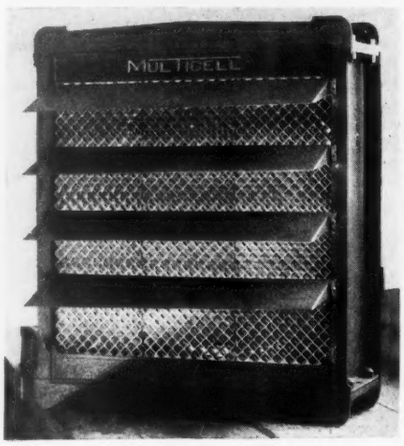
Bullard-Davis Rubber Face Mask

AN improvement to its line of gas masks has been announced by Bullard-Davis, Inc., 67 Wall St., New York City. This improvement consists of a rubber face piece which is said to have a markedly increased tendency to hold shape and to possess superior resistance to wear. The exhalation valve has been located so as not to interfere with head motion in any direction.

Multicell Unit Heater

A UNIT heater of unique design has been introduced by the Multicell Radiator Corporation, Lockport, New York.

Its heating surface is comprised of removable sections of cellular design and of one-piece seamless copper construction. Their accordion-like pattern permits the sections to expand and contract within themselves thus eliminating the necessity of special mounting to compensate for expansion and



contraction strains. The sections are mounted in a rigid all-cast frame by means of compression unions at top and bottom.

Multicell units heaters employ no fin surface. All air passing through these unit heaters is broken up into a large number of small streams bringing each particle intimately in contact with all prime heating surface.

Sticht "Paragon" Megohmer

ANNOUNCEMENT has been made by Herman H. Sticht & Company, 15 Park Row, New York, N. Y., of the marketing of the "Paragon" Megohmer, a Siemens & Halske product.

This instrument is made up of two parts; the generator, and the instrument proper. The measuring system

is of the differential type with three coils—one series coil, one shunt coil, and one compensating coil which assures proper scale characteristics. The generator is a self-contained unit.

At the crank-handle end are the fiber gears, and next to the gears and in the same section of the generator housing is the improved-type centrifugal clutch that assures constant voltage at speeds in excess of 120 r.p.m. of the crank.

All instruments are inclosed in composition cases and are available in six range combinations.

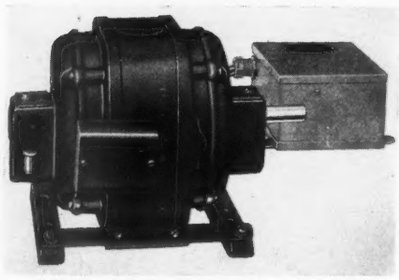
Baldor Type CC Capacitor Motor

BALDOR Electric Company, 4351 Duncan Ave., St. Louis, Mo., announce an addition to its line in the development of fractional-horsepower, single-phase, 60-cycle capacitor Type CC, high-torque motors.

These motors are available in constant-speed ratings of 1,750 and 1,140 r.p.m. The motor is totally inclosed and provided with a spring base which absorbs any residual vibration and still preserves the alignment.

A skeleton-type stator is used in its construction. The winding has two phases; one of which is connected to the line, the other is connected to the static condenser which constitutes the running connections.

For starting, an extra condenser is



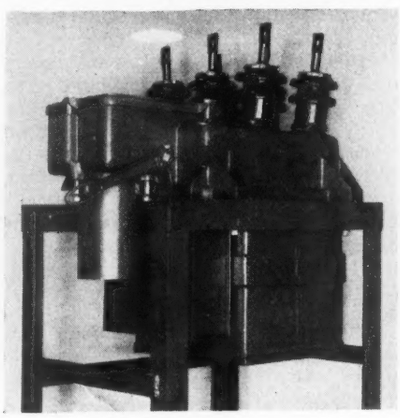
interconnected to both the main and auxiliary winding in such a manner so as to give the maximum starting torque. When the motor is up to speed a centrifugal switch disconnects the condenser used in starting. The rotor is of a special squirrel-cage type provided with an extra heavy shaft which revolves in bronze sleeve bearings.

Westinghouse Type "FO-22" Oil Circuit Breaker

THIS device, recently brought out by the Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa., is intended specifically for outdoor service. It is available in two- and three-pole single-throw sizes, in capacities of 400, 600 and 800 amp. for operating voltages of 7,500 or less, and with an interrupting capacity of 3,500 amp. at 7,500 volts.

Although the breaker was designed primarily for pipe or structural-steel framework mounting, it can be adapted to wall or pole mounting. It is arranged for either manual, d.c. or a.c. solenoid (d.c. solenoid-Rectox combination) operation. The solenoid mechanism bolts directly to the manually operated breaker and consequently the change from manual to electrical operation, or vice versa, can be made with very little trouble. The Rectox is housed in a weatherproof transformer case which can be mounted at any point conveniently close to the breaker.

At any point of the closing stroke the automatic breaker is mechanically trip free. It can be equipped with the following attachments: A maximum of three series trip attachments having inverse time limit features; three transformer trip attachments having

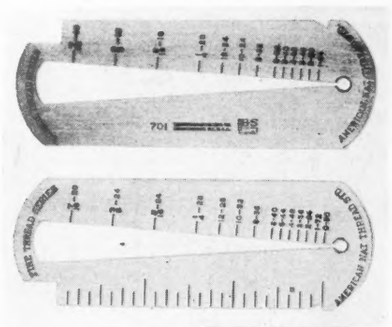


instantaneous, inverse time limit or direct-trip features; a shunt-trip attachment; a low-voltage release attachment; a Veeder counter, and a four- or six-pole, rotary-type auxiliary switch.

Brown & Sharpe American National Standard Screw Gage No. 701

BROWN & Sharpe Manufacturing Company, Providence, R. I., announce the American National Standard Screw Gage No. 701, a device for determining screw threads according to the American National (and U. S.) Screw-Thread Standards.

One side of the gage is graduated



for the fine-thread series, the other side for the coarse-thread series.

A 3-in. scale graduated in eighths is provided on one outer edge of one side. This scale allows the length of screws to be determined. Slots at either end of the scale permit the heads of both round- and flat-headed screws to be set against a positive stop, when measured.

Oxweld Type W-17 Welding Blowpipe

OXWELD ACETYLENE COMPANY, 30 East 42nd St., New York City, has recently announced another blowpipe. The Type W-17, as it is called, employs the same low-pressure injector principles used in other Oxweld blowpipes. It is a fullsized blowpipe, and with the No. 4 welding head it weighs but 24 oz. The long thin shape of the welding heads makes it possible for this blowpipe to be used in practically all inaccessible places.

The tip and welding head are of one-piece construction, being combined in a long and slender stem of the gooseneck type. The injector is located at the base or handle end of the stem. Each welding head has its own nut for attaching it to the handle of the blowpipe. The nut has been constructed so that it extends beyond the injector when the welding head is detached from the blowpipe and serves to protect the injector from damage due to careless handling. A fine pitch thread makes it possible to tighten or loosen the nut easily without the use of a wrench.

Schauer Machine "Ideal" Speed Lathe

A TOOL, known as the "Ideal" speed lathe, to finish and polish small parts, is now being marketed by The Schauer Machine Company, Cincinnati, Ohio. The construction of the lathe embodies a ½-hp. two-speed, totally-inclosed, dust-proof motor; an automatic brake; ball bearings; an extension in the motor spindle to take on extra long rod stock, and a 4-in. chuck.

High or low speeds are selected by means of a speed-control switch in the motor base. Either speed, as desired, is determined by the position of the switch. The current is cut in by a slight backward push on the hand lever, and is cut off and the brake simultaneously and automatically applied. A forward movement of the hand lever stops the motor in three seconds when running at high speed, and one and one-half seconds at low speed. This brake operates against a large-diameter extended surface of the motor spindle.

Means are provided for regulating the brake pressure and adjusting for wear of the brake shoe.

On d.c. the design provides for speeds of 2,700 and 1,350 r.p.m.; on a.c. 3,400 and 1,700 r.p.m. A hollow spindle within the motor permits insertion of 1-in. rod or tube stock 9 in. long from the face of the chuck, thus making it possible to finish or polish 12- to 16-in. rods without the necessity of an end support.

As a unit it is regularly equipped with a three-jaw universal chuck to take 1-in. rod or tube stock, and chuck up to 4 in. Double-row, dust-proof ball bearings operating in grease are provided on both chuck and rear end of the spindle. It can be had for bench mounting, as illustrated, or with a pedestal for floor mounting.

Nichols-Lintern Electro-magnetic Sander

DEVELOPED for use on overhead cranes, the Lintern Electro-magnetic Sander, illustrated, was recently put on the market by the Nichols-Lintern Company, 7960 Lorain Ave., Cleveland, Ohio.

Mounted on the crane above the rail,

the sander is controlled by a switch located in the cab. Its magnet coil is designed for continuous operation. A chromolax strip heater is used for heating the air chamber. The sander valve is made of brass; the hopper of heavy galvanized iron, and measures 12x12x17 inches.

Fusion Welding C-No. 6 Fluxed Rod

WELDITE C-No. 6 Fluxed, a rod designed for carbon arc welding, is announced by the Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill. This rod is adaptable for the welding of mild-steel plates and castings.

Heavy section welding of mild steel furnishes a very favorable application for this rod as the weld deposits are sound and strong, also ductile qualities of the deposit make it extremely efficient in foundry work, it is claimed.

Swoboda "Falcon" Melting Tank

ANNOUNCEMENT has been made by H. W. Swoboda, Inc., 3400 Forges St., Pittsburgh, Pa., of the marketing of an electrically heated compound melting tank, designated "Falcon," which was designed to melt and heat compound or similar substances such as asphaltum to 550 deg. F. The equipment, heater and tank, is installed in the second floor of a building in such a manner that it is charged from the second floor; the liquid compound being drained off on the first floor.

The tank is made of boiler plate and divided into a lower and upper section; the lower contains the electric heater, and the upper provides sufficient space for receiving the contents of a standard steel drum of compound. The cover is hinged to the tank, and is provided with heat insulating material. The bottom of the tank terminates in a drain with stop cock, through which the molten compound is passed out.

It is made in three capacities, that is, for melting compound at the rate of 100, 250 or 400 lb. per hour. It is suitable for three-phase a.c. service at 115, 230 and 440 volts respectively. A transformer of the air-cooled type supplies the proper potential to the heater and an automatic thermometer control maintains the temperature within the tank constant.

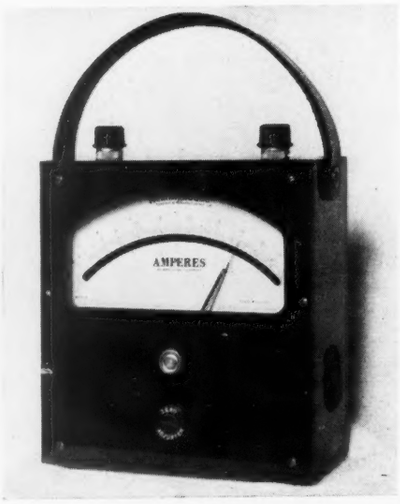
Westinghouse Motor-Starting Ammeter

A MOTOR-starting ammeter, designated Type PY-5, which enables an accurate measurement of the instantaneous starting current of a.c. and d.c. motors; a measurement accomplished heretofore only with an oscillograph, has been placed on the market by the Westinghouse Electric & Manufacturing Company, E. Pittsburgh, Pa. This instrument can be used also as an ordinary ammeter.

Such measurements as starting current, locked-rotor current, and running current are made without disconnecting the instrument from the line. The instrument has a double range, and change over from one range to the other is accomplished simply by turning a switch on the side of the case. This switch may be seen in the illustration at the bottom of this column.

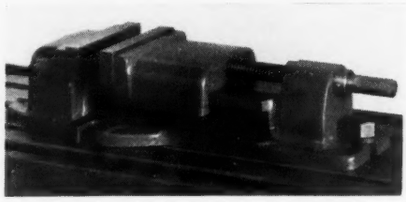
This instrument, which is direct reading, is suitable for general testing and laboratory work, where especially high and positive accuracy is required and particularly on alternating current, and, because of the permanence of calibration, for use as a transfer standard for calibrating and checking other instruments.

This ammeter has a moving iron vane mechanism with an air chamber for damping the oscillations of the pointer. The moving element is quite light and very responsive to slight quick changes in current. The case is made of micarta with a walnut finish and nickel trimmings, and is provided with a flexible leather handle.



Cincinnati Milling Machine Plain and Swivel Vises

INCREASED strength and rigidity are claimed for the vises announced by the Cincinnati Milling Machine Company, Cincinnati, Ohio. The fixed jaw section of these vises and the abutment, which forms the support for the

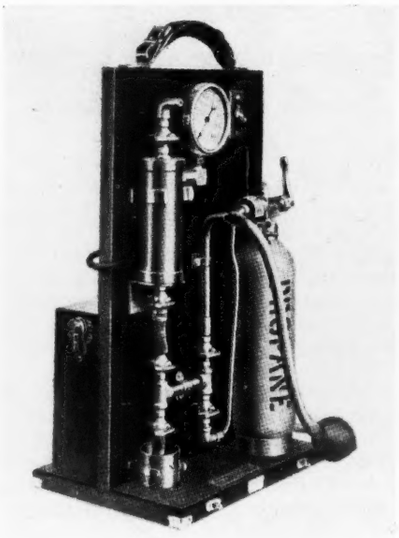


screw that moves the movable jaw or slide, has been materially enlarged. The jaws are made of hardened and ground steel and are held securely to the vise body and slide.

The bottom of the plain vise is finished so as to enable it to be converted into a swivel vise by assembling to a swivel base graduated in degrees. The No. 3 plain and swivel vises have jaws 6⅛ in. wide by 1⅝ in. deep with a 4-in. opening, while the No. 5 vise in both styles has jaws 8⅝ in. wide by 2½ in. deep with a 7-in. opening. These vises form a part of the regular equipment of the milling machines manufactured by this company, a swivel vise on the universal machine and a plain vise on the plain and vertical machines.

Mine Safety Appliances "Jones" Gas Detector

WEIGHING 26 lb., the gas detector, illustrated, was developed by G. W. Jones, explosive chemist, United States Bureau of Mines, for practical field use in approximating the explosive content or an oxygen deficiency of atmospheres in confined spaces. It is being marketed by the Mine Safety Appliances Company, Braddock, Thomas and Meade Sts., Pittsburgh, Pa. It measures 19x12x9 inches.

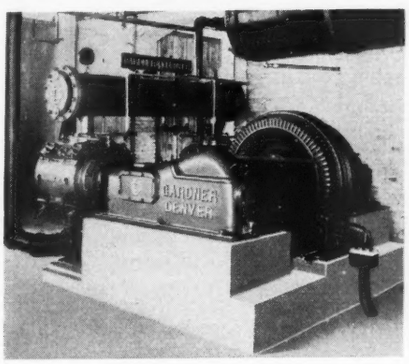


This detector consists essentially of a bomb in which a spark plug is inserted and to which a pressure gage is attached. In addition, there are the following component parts: A measuring device, a cylinder of Propane, a water cup, an aspiration bulb, two dry cells, an automatic spark coil, an ignition switch, necessary valves, etc. The assembly is compactly mounted on a wooden stand; a canvas cover envelopes the entire outfit when not in use.

Its field of application includes manhole entrances to electrical conduits, cables, gas mains, and sewers; garages; chemical plants; blast furnaces; artificial gas plant; and so on.

Gardner-Denver Synchronous-Motor-Driven Air Compressors

DUPLEX, two-stage, synchronous-motor-driven air compressors are now being offered by The Gardner-Denver Company, Quincy, Ill., to complete its standard line of belt- and steam-driven machines.

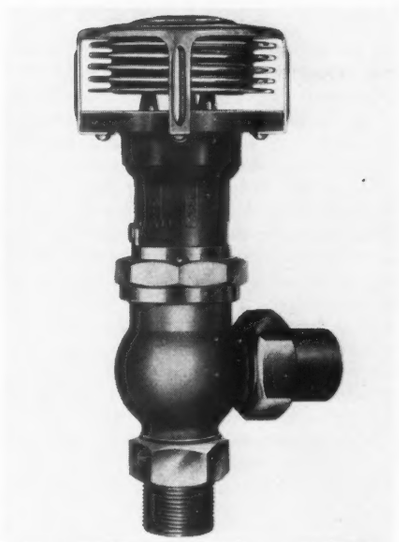


These units are of the heavy-duty type with the motor placed between the two main bearings and mounted directly on the crankshaft. A special feature is the use of roller bearings on the main shaft.

Sylphon Automatic Radiator Valve

AN automatic radiator valve, Sylphon No. 875, has been announced by the Fulton Sylphon Company, Knoxville, Tenn. The valve is a combination packless radiator valve and temperature control unit, suitable for any two-pipe steam heating system utilizing either floor or ceiling radiators. The valve operates automatically when there is a variation in the room temperature regulating the flow of steam to the radiator.

A thermostatic element is made from a Sylphon bellows which develops sufficient power to close the valve tightly without undue increase of temperature in the room. The thermostatic element is responsive only to the temperature of the air surrounding it, and



is not influenced by the temperature of the steam pipe or the radiator.

By rotating the thermostatic head just as one would turn an ordinary radiator valve handle, different temperatures are obtained. A bakelite portion is provided with markings "hot," "medium," "cold" and "shut."

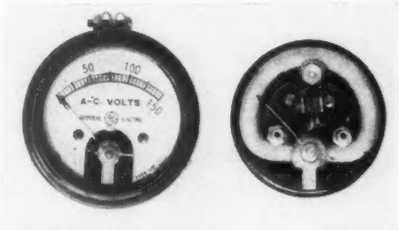
These valves can be supplied in sizes from ½ to 1½ inches.

General Electric Instruments

SMALL voltmeters and milliammeters in 2¼- and 3-in. cases, for use on both a.c. and d.c. lines, have been introduced by the General Electric Company, Schenectady, New York. The meters have molded compound cases and bases, the cases being threaded so as to screw on the base.

These small D'Arsonval instruments are equipped with full-wave copper oxide rectifiers mounted within the case. The rectifiers permit the instruments to be used on a.c. circuits, making it possible to provide a.c. instruments in low voltage and current rating having the high sensitivity, low power consumption, and damping of the D'Arsonval element. The voltmeters are available in ratings from 2 to 150 volts, and the milliammeters in ratings from 0.5 to 15 milliamperes.

The panel-type instrument in a 3-in. case is designated as Type DO-14X, the

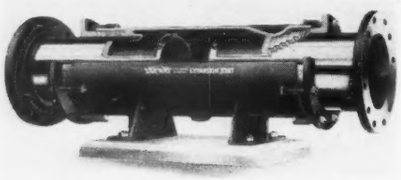


one in a 2¼-in. case as Type DW-1X. A portable voltmeter, similar to Type DW-1X but with a rectangular subbase, a double range 10-500 volt scale, and a knob for adjusting to read either a.c. or d.c. is designated as Type DW-2X.

Yarnall-Waring Expansion Joint

AN accompanying drawing shows one of a line of cylinder-guided expansion joints which are being made by the Yarnall-Waring Company, 102 E. Mermaid Lane, Philadelphia, Pa. These joints are made for pressures of 125 and 250 lb. per sq. in., and in sizes from 2½ to 24 in. in diameter. They are also made in three styles; the first as shown, the second having the addition of a base, and the third consisting of two opposed expansion joints, also with a base. Each type and each size is made with a total possible expansion for each sleeve of 4, 8 or 12 inches.

The joints are made of steel throughout, with the sliding sleeve chromium-plated to preserve the surface and prevent sticking. The guide cylinder is intended to secure positive



alignment, while the stuffing box is especially large to provide for ample packing. A dirt pocket is provided in the bottom of each style.

Johns-Manville Asbestos Wall Tile

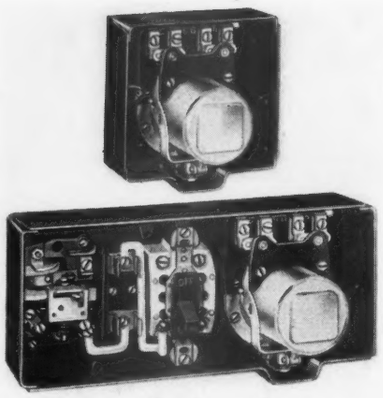
JOHNS-MANVILLE Corporation, 292 Madison Ave., New York, N. Y., has announced another product, "asbestos wall tile," which, according to the announcement, is durable, waterproof, and fireproof.

Formed of asbestos fibers and Portland cement, it is united under great pressure into large sheets and grooved off in squares to give the effect of individual units. The wide range of attractive color combinations in both the tile sheets and the base and cap molding is made possible by the use of special lacquer enamels. An important feature of this product is its ease of application. The large sheets can be cut readily with a hand-saw and erected without recourse to cement. This method of erection is accomplished by means of brass retention clips which hold the sheets in place. Brass strips lacquered to match the tile, lock into the clips effectively concealing the joints.

Allen-Bradley Automatic Pressure Switch

ALLEN-BRADLEY Company, 286 Greenfield Ave., Milwaukee, Wis., announce Bulletin 830 Pressure Switch for starting and stopping compressor and pump motors.

Size B pressure switch is made in four forms in various combinations with or without overload breakers, dis-



connect switches and fuse clips. This unit is rated: 1 hp.,110-220 volts for direct current; 1 hp., 110 volts, and 2 hp., 220 volts for alternating current.

Size C switch is rated up to 5 hp. For larger ratings the Size B pressure switch is used as a pilot control for magnetic starters of any rating.

National Cork "Nacotex" Gasket Compound

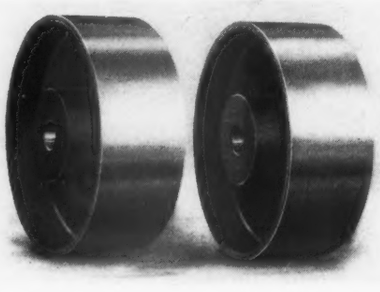
FOR equipment having air, water, or oil connections, the National Cork Products Company, Newark, N. J., has announced a gasket compound known as "Nacotex," which is neither a paste nor a cement. This material is not affected by oil, grease, kerosene, or water, and can be used on ammonia and gas lines. According to the announcement, it does not crumble, break, disintegrate or become spongy, neither will it blow out when subjected to extreme pressures.

Nacotex possesses a very definite "body," which permits building up to offset surface irregularities and depressions. It sets almost instantly and may be used in old or new gaskets or without a gasket on gound-fit joints. The material is supplied in tubes and in pint, quart, and gallon tins.

Tool Steel Brake Wheels

ABILITY to stand up under the most severe operating conditions is a feature emphasized by the Tool Steel Gear & Pinion Company, Cincinnati, Ohio, in introducing "Tool Steel" brake wheels for mill-motor service.

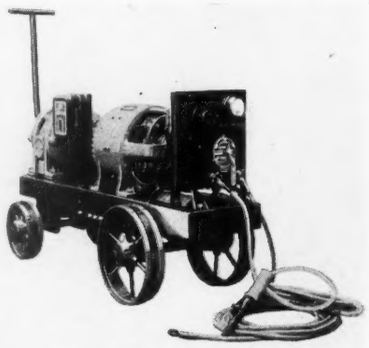
These wheels are manufactured from



low-carbon steel blanks, the face specially hardened and toughened from 85 to 95 scleroscope, it is claimed. The depth of the hardness penetrating one-third the rim thickness allowing two-thirds tough center to back up the hard wearing surface which is ground after hardening.

Wilson Model S 100-Ampere Welder

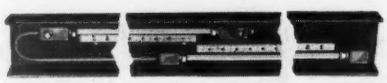
A SMALL, lightweight arc welder, suitable for operation in limited space and designated as the Model S, has been placed on the market by the Wilson Welder & Metals Company, Inc., Hoboken, N. J. This machine is mounted on the Type 100-W frame.



This 100-amp. welder has a rating of one hour at full load without more than a 50-deg. C. temperature rise, and has a welding range of 30 to 125 amp. Three models are available; electric-motor driven, gasoline-engine driven, and belt driven.

Meriam U-Tube Mercury Manometer

A SPECIAL type of U-tube mercury column manometer designed to measures pressures up to 50 lb. per sq. in. and which is open to the atmosphere or complete vacuum has been de-



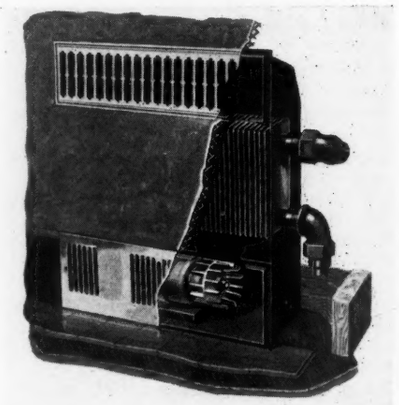
veloped by the Meriam Company, Cleveland, Ohio. This instrument is also suitable for measuring differentials on line pressures up to 500 lb. per sq. in. The special construction is intended to eliminate the difficulty sometimes met with in attaching large precision instruments of this kind to the connecting pipes.

To permit the manometer connecting union on the pressure side to be brought out at the middle instead of the top of the instrument, the upper part of one of the arms is omitted, and the pressure tube is connected to the usual gasketed union at a point a little above the normal zero line of the liquid.

Air-Way Electric Appliance "Aeriet"

DEVELOPED for heating offices, small areas, and other quarters, the "Aeriet," illustrated, and manufactured by the Air-Way Electric Appliance Corporation, Toledo, Ohio, utilizes the same principle of positive mechanical air circulation employed by Air-Way unit heaters. It may be used in place of the ordinary radiator and can be connected to the same pipes on either steam, hot water, or vapor systems.

Live, warm air is gently forced into that part of the room where needed, and according to the manufacturer, heating efficiency is increased, and a saving in fuel effected.



Weighing 34 lb., the standard 14-in. unit is the equivalent of a 40-ft. radiator, weighing approximately 200 lb. It requires less than one cubic foot of space within the walls, thereby saving floor space. Only two grills which harmonize with any decorative treatment are visible. Rooms may be individually heated and temperatures controlled either manually or by electric thermostat. Control of each room prevents overheating and its resultant waste of fuel.

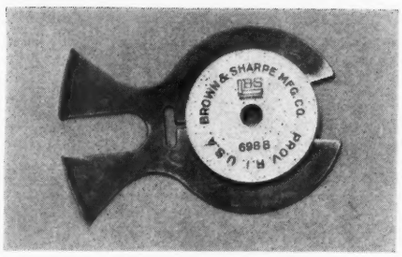
Circulation of air created by the Aeriet forces the warm air out into the working zone of the room, diffusing it with the cooler air thus giving a more uniform temperature.

It is also available in an electric unit, either of the built-in or portable type.

Brown & Sharpe Wire Gage Selectors, Nos. 698A and 698B

WIRE gage selectors, Nos. 698A and 698B, have been announced recently by the Brown & Sharpe Manufacturing Company, Providence, R. I. These selectors cover up the slots in the wire gage adjacent to the one being used, so that the one slot for any particular size is made accessible for fast and easy use. Spring fingers on the selector arm snap around the stud on the disk, holding the selector in place on the gage.

Selector No. 698A is for use on



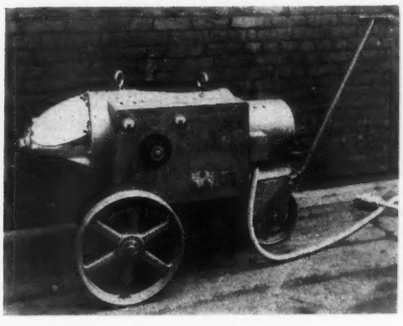
Brown & Sharpe wire gages Nos. 688 (5 to 36), and 690 (6 to 36); selector No. 698B is for use on Brown & Sharpe wire gages Nos. 688 (0 to 36), 690 (1 to 36), 692, and 694.

Westinghouse "Flex-Arc" Welders

THE Westinghouse Electric & Manufacturing Company, E. Pittsburgh, Pa., announces an original development in arc welding machines that is now applied to its line of single-operator welders, and which makes it much easier for the operator to strike and maintain the arc under all operating conditions, and eliminates explosive arc characteristics.

Welding machines employing this principle are known as "Flex-Arc" welders. The Flex-arc principle, although not previously announced to the market, has been in use on the popular ratings of Westinghouse Welders since the latter part of 1929, it is stated.

This unusual improvement in welding machine characteristics is obtained by the use of a special piece of apparatus, known as a "Flexactor," replacing the reactor formerly used. The volt-ampere curve of a welding generator indicates a certain current for a given voltage. However, it is well known to designers that such a current is not obtained at all times. In striking the arc, the current exceeds the steady value shown on the curve, causing the troublesome sticking of the electrode. The chief function of the Flexactor is to prevent this overshooting of current and resultant tendency of the electrode to stick. Furthermore, any lengthening of the arc causes the current to momentarily drop below the normal steady value tending to interrupt the arc, all of which is corrected by the Flexactor. In the arc welding process, momentary short circuits are caused by globules of metal passing across the arc. Such

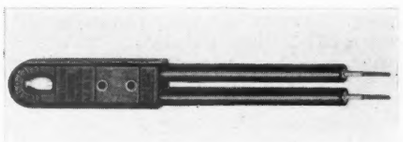


short circuits result in current surges and arc explosions just as in striking the arc. This explosive action is eliminated by the use of the Flexactor.

Other features of this machine are drip-proof, rugged and compact construction; mobility; wing nut terminals for welding cable connections; single rheostat adjustment with calibrated dials for accurately adjusting the welding current over the entire range; and the high over all efficiency.

Brach "Test-O-Lite"

FOR locating faults in electrical circuits, a device, designated "Test-O-Lite," has been placed on the market by the L. S. Brach Manufacturing Corporation, Newark, N. J. It may be used on a.c. and d.c. circuits of from 100 to 500 volts.



Test-O-Lite has two small electrodes and when used on d.c. circuits will indicate polarity. At 100 volts it has an estimated life of 4,000 hr., but as the voltage is increased the life is shortened. In size it compares with a fountain pen and may be carried in the vest pocket.

Bishop "Contact" Cable

CLOSING a circuit by pressing or pinching a cable anywhere along its length features the "Contact" cable developed by the Bishop Wire and Cable Corporation, 420 East 25th St., New York City.

This novel feature results from the unique construction of the cable. Two

conductors, inclosed by the outside insulation, are left bare but separated from each other by an isolation cushion. When the cable is pressed, this isolation cushion yields and permits the outer conductor to contact with a wire which is always in contact with the inner conductor. Thus the circuit is closed.

By releasing the pressure, the cushion returns the outer conductor to its normal position thus opening the circuit.

It is waterproof, dustproof, and can be made acidproof. Although it is generally used with light circuits, transformed to a maximum of 48 volts, its application is suggested by the manufacturer on remote control work of a varied character.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

(92) MOTORS—Folder GEA-1231, induction motors, "900 Series," riveted frame; "500 Series," skeleton frame; three-phase, Types KTB, FTB, and MTB. two-phase, Types KQB, FQB, and MQB.—General Electric Company, Schenectady, N. Y.

(93) AIR CIRCUIT BREAKERS — Leaflet GEA-945A Type CK-1 and CK-2 air circuit breakers.—General Electric Company, Schenectady, N. Y.

(94) SAFETY SWITCHES—Dimension pages, 52-62 inc. on Types A and C switches.—The Trumbull Electric Manufacturing Company, Plainville, Conn.

(95) BATTERIES—Bulletin No. 203, "Exide Batteries for Control Bus Operation." Fifteen pages of engineering information.—The Electric Storage Battery Company, Philadelphia, Penna.

(96) INSTRUMENTS—40-page catalog 20, "Galvanometers," covers practically the entire range for which these instruments may be used.—Leeds & Northrup Company, Philadelphia, Pa.

(97) METERS—Bulletin No. 781, Power-Plant Series No. 5, CO_2 meters (electrical), 24 pages. — Leeds & Northrup Company, Philadelphia, Pa.

(98) WASTE ELIMINATION—A booklet, 1840A, entitled "Stop Waste" published as a contribution to the continuous campaign for the elimination of waste in American Industry carried on in connection with the movement sponsored by the American Society of Mechanical Engineers with the co-operation of the American Management Association. — Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(99) INSTRUMENTS—Bulletin No. 536, Power Cable Fault Bridge, 8 pages.—Leeds & Northrup Company, Philadelphia, Pa.

(100) SHOP TOOLS—Folder, "A safe ladder for greater efficiency in industrial use."—The Dayton Safety Ladder Company, Cincinnati, Ohio.

(101) POWER TRANSMISSION—A 44-page booklet on sprockets for roller chain drives. The standard types of sprockets —plate, integral-hub and detachable hub —are illustrated and described. Complete mechanical specifications are shown, for single and multiple-strand chains . . . for drives rated up to 672 horsepower together with maximum power and speed limits. Other information includes recommended heat-treatment for sprockets, instructions for ordering, specifications as to keyseats, a table of maximum hub diameters according to pitch of chain, and so on.—The Diamond Chain & Manufacturing Company, Indianapolis, Ind.

(102) METALS—A 12-page folder, "Metal Equipment Exposed to Corrosive Brines." —The American Rolling Mills Company, Middletown, Ohio.

(103) SPEED REDUCERS—Bulletins P-1 and H-1; "Revocentric," infinitely variable; "Heliocentric," positive fixed speed reducers, respectively. — Universal Gear Corporation, 327 S. LaSalle St., Chicago, Ill.

Coming Events

American Welding Society — Annual meeting at society headquarters in New York City, April 22 to 25. Secretary, M. M. Kelly, 33 W. 39th St., New York City.

National Power Show—Held in connection with the International Textile Exposition, Mechanics Bldg., Boston, Mass., April 28 to May 3. J. W. H. Myrick, Treasurer, New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass.

American Gear Manufacturers Association—14th Annual Meeting, May 1, 2, and 3. Hotel Gibson, Cincinnati, Ohio. T. W. Owen, Secretary, 3608 Euclid Ave., Cleveland, Ohio.

National Fire Protection Association—1930 annual meeting, May 12 to 15, Atlantic City, N. J.

California Safety Society—The Eighth Annual California First Aid Meet, and the Seventh Annual Pacific Coast Safety Conference, Scottish Rite Auditorium, San Francisco. May 14 to 16. Headquarters, Palace Hotel, San Francisco.

National Association of Foremen—Convention, June 6 and 7. Civic Auditorium and Chamber of Commerce, Toledo, Ohio. Harry J. Baumker, Convention Secretary, 316 10th St., Toledo, Ohio.

American Society of Mechanical Engineers—Semi-annual meeting of the Society, June 9 to 12, 1930. Hotel Book-Cadillac, Detroit, Mich.

National Electric Light Association—Annual Convention at Municipal Auditorium, San Francisco, Calif., June 16 to 20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

Association of Iron and Steel Electrical Engineers—Iron and Steel Exposition, Broadway Auditorium, Buffalo, N. Y., June 16 to 20 incl. John F. Kelly, Managing Director, Empire Building, Pittsburgh, Pa.

American Institute of Electrical Engineers—Annual Summer convention, June 23 to 27, Toronto, Ont. Annual Pacific Coast convention, Sept. 2 to 5, Portland, Ore.

Coming Events—April

National Safety Council—19th Annual Safety Congress, Sept. 29 to Oct. 4. Hotels William Penn and Fort Pitt, Pittsburgh, Pa.

(104) PUMPS—"Pump Guide" No. 12, a 48-page indexed booklet on pumps and their applications, other information and miscellaneous tables. — Chicago Pump Company, 2336 Wolfram St., Chicago, Illinois.

(105) SHOP TOOLS—A 20-page booklet supplements catalogs Nos. 31 and 139. New Tolls—to help good workmen do better work.—Brown & Sharpe Manufacturing Company, Providence, R. I.

(106) MATERIALS HANDLING—Catalog No. 30, Steel Belt Conveyors. Tables, charts, diagrams, and applications.—Sandvik Convey Manufacturing Company, 21 Amsterdam St., Newark, N. J.

(107) STEEL PRODUCTS—A 32-page illustrated booklet fully indexed; Armco Ingot Iron, sheets and formed products. —American Rolling Mill Company, Middletown, Ohio.

(108) MOTORS — Bulletin 12 describes Type C C capacitor motors. — Baldor Electric Company, 4351 Duncan Ave., St. Louis, Mo.

(109) MOTORS—Bulletin No. 106, Type AA induction motors with ball bearings for two-, and three-phase, a.c. circuits.—Reliance Electric & Engineering Company, Ivanhoe Road, Cleveland, Ohio.

(110) MOTORS—"The Most Efficient Drive in Industry," a 56-page booklet on what synchronous motors are doing on industrial drives. — Electric Machinery Manufacturing Company, Minneapolis, Minn.

(111) PROTECTIVE DEVICES — Circular 1737-E, "Lightning Investigation, Discoveries, and Control," presents an account of the lightning investigations made by Westinghouse Engineers during 1929, conclusions derived from this research, and descriptions of the construction and the application of autovalve lightning arresters.—The Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(112) WELDING—Welding Wire Research, a 10-page booklet.—Page Steel & Wire Company, 230 Park Ave., New York, N. Y.

(113) WIRING DEVICES—Bulletin 38-CD describes solderless, compression-type terminal lugs for use on switches, transformers, oil circuit breakers and other points where solderless type lugs are necessary.—The Delta-Star Electric Company, Chicago, Ill.

(114) TROLLEY—Bulletin 5025, covering the complete line of Ace Trolleys, is now ready for distribution by the manufacturer.—Robbins & Myers, Inc., Springfield, Ohio.

(115) WEIGHING APPARATUS—"Beginning the Second Century," a 20-page booklet on the history of the development of weighing machines, produced in celebration of the centennial anniversary of the invention of the platform scale by Thaddeus Fairbanks and the founding of the company which bears his name.—Fairbanks, Morse and Company, 900 S. Wabash Ave., Chicago, Ill.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Power-Factor Problems Solved by Scale

POWER-FACTOR problems can be solved by scale without resorting to degrees or functions of angles, squares or square roots, "kw.," or "kva." All that is needed is a scale, a pencil, and paper. A right-angle triangle with the sides in proportion 3 to 4 to 5, and a small T-square will save time and make the work more accurate. A few typical problems are worked out here so that the principles may be readily understood and applied to other power-factor problems.

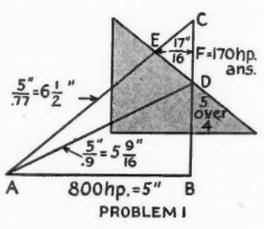
1. Draw horsepower as a horizontal line to a suitable scale as suggested in the following tabulation:

For 150 hp. or less,	**let 1/16 in. = 2 hp.**
Up to 500 hp.,	**let 1/16 in. = 5 hp.**
Up to 800 hp.,	**let 1/16 in. = 10 hp.**
Up to 2,000 hp.,	**let 1/16 in. = 25 hp.**
Up to 8,000 hp.,	**let 1/16 in. = 100 hp.**

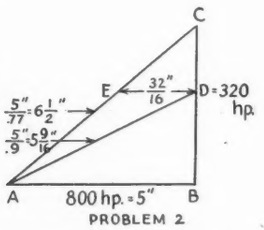
2. Lines slanting upward to the right represent lagging power-factor and their lengths are determined by dividing horsepower by lagging power factor.

3. Lines slanting downward to the right represent leading power factor and their lengths are determined by dividing horsepower by leading power factor.

4. Horsepower at unity power factor will be represented by horizontal lines.



PROBLEM 1



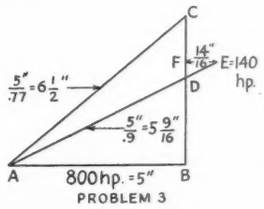
PROBLEM 2

Cut a right-angle triangle from cardboard with 3-in., 4-in., and 5-in. sides (the carpenters' old 3-4-5 way of laying out a square corner). Using the 5-in. side over the 4-in. side gives the correct slant (rule 3) for 0.8 power factor.

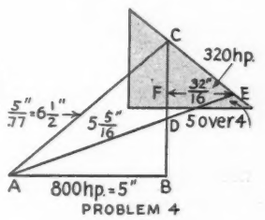
Problem 1. Given: an 800-hp. load at 0.77 power factor. How much horsepower in 0.8-leading-power-factor synchronous motors must be substituted to raise the power factor to 0.9?

Solution: use scale 1/16 in. = 10 hp. Draw 80/16 in. (5-in.) horizontal line AB and a vertical line at B. Divide 5 in. by 0.77 = 6½ in. In the vertical line, determine a point, C, 6½ in. from A, and connect C with A. Divide 5 in. by 0.9 = 5 9/16 in. Determine a point, D, on the vertical line 5 9/16 in. from A and connect D with A. Apply the 0.8-leading-power-factor slant of the triangle at D and draw DE. Measure the horizontal distance EF = 17/16 in. or 170 hp., answer.

Problem 2. Given: an 800-hp. load at 0.77 lagging power factor. How much horsepower in unity-power-factor synchronous motors must be substituted to raise the power factor to 0.9?



PROBLEM 3



PROBLEM 4

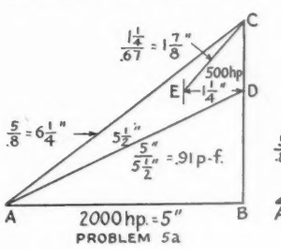
Solution: draw the base line, the vertical, and the two lagging-power-factor slants as for Problem 1 (or use the same diagram). Draw a horizontal line from D to AC at E. Measure DE = 32/16 in. or 320 hp., answer.

Problem 3. Assume that an 800-hp. load at 0.77 lagging power factor has been raised to 0.9 lagging power factor. How much horsepower can be added without increasing the original system heating?

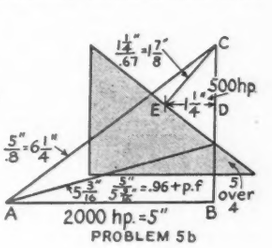
Solution: draw the base, the vertical, and two lagging power factor slants as for Problem 1, but extend AD to E so that AE is 6½ in long (the same as AC). Measure the horizontal distance EF = 14/16 in. or 140 hp., answer.

Problem 4. Given: an 800-hp. load at 0.77 lagging power factor. What power factor will result if 320 hp. in 0.8-leading-power-factor synchronous motors is added?

Solution: draw base, vertical, and 0.77-power-factor slant as for Problem 1. From C, draw an 0.8-leading-power-factor slant, determine a point, E, on it 32/16 in. (320 hp.) from the vertical, and draw



PROBLEM 5a



PROBLEM 5b

Courtesy of General Electric Company.

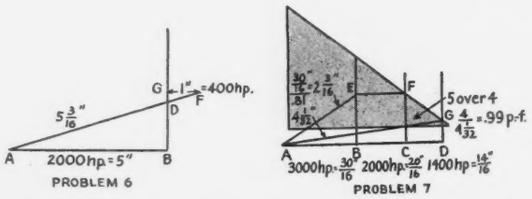
INDUSTRIAL ENGINEERING'S DATA SHEETS

a horizontal line, *EF*. Draw *ADE:* Measure *AD* = 5 5/16 in. Divide 5 in. by 5 5/16 in. = 0.94 power factor, answer.

Problem 5. Given: a 2,000-hp. load at 0.8 lagging power factor in which one 500-hp. group of motors has a 0.67 lagging power factor. What power factor would result if (a) unity-power-factor synchronous motors were substituted for this group, and what if (b) 0.8-leading-power-factor synchronous motors were substituted?

Solution: choose a scale of 1/16 in. = 25 hp. Draw *AB*, 80/16 in. (5 in.), and vertical at *B*. Divide 5 in. by 0.8 = 6¼ in. Determine a point, *C*, on the vertical 6¼ in. from *A* and connect *A* with *C*. Draw a line parallel to, and 1¼ in. (500 hp.) from *BC*. Divide 1¼ in. by 0.67 = 1⅞ in. In the last-drawn line, determine a point, *E*, 1⅞ in. from *C* and draw *CE*. For solution of (a), draw the horizontal *ED* connecting *E* with *BC*. Measure *AD* = 5½ in. Divide 5 in. by 5½ = 0.91 power factor, answer. For solution of (b), proceed as in (a), but draw an 0.8-leading-power-factor slant from *E* down through the vertical *D*. Measure *AD* 5 3/16 in. Divide 5 in. by 5 3/16 = 0.96 power factor, answer.

Problem 6. Under the conditions in Problem 5b, how much load can be added without increasing the original system heating?



PROBLEM 6

PROBLEM 7

Solution: draw the base, vertical, and 5 3/16-in. lagging-power-factor slant *AD* as for Problem 5b and extend *AD* to *F*, 6¼ in., to equal *AC*. Measure the horizontal *FG*, 1 in. or 400 hp., answer.

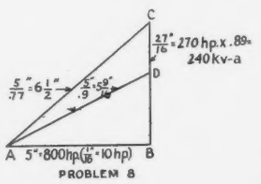
Problem 7. Given: 3,000 hp. at 0.81 power factor and 2,000 hp. in unity-power-factor synchronous motors. What will be the system power factor if the remaining 1,400 hp. is in 0.8 leading-power-factor synchronous motors?

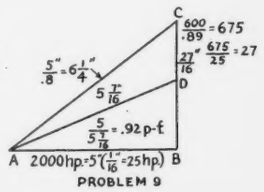
Solution: total horsepower 3,000, plus 2,000, plus 1,400 = 6,400. Use a scale of 1/16 in. = 100 hp. Draw a base line *AD*, 4 in. long, to represent 6,400 hp. Draw perpendiculars at *B*, 30/16 in. from *A;* at *C*, 20/16 in. from *B;* and at *D*. Divide 30/16 in. by 0.81 = 2 3/16 in. Determine a point, *E*, on the perpendicular over *B* and 2 3/16 in. from *A*, and draw *AE*. Draw a horizontal (unity-power-factor) line *EF* to the perpendicular over *C*. Draw an 0.8-leading-power-factor slant from *FG* down through the perpendicular over *D*. Draw *AG;* it measures 4 1/32 in. Divide 4 in. by 4 1/32 = 0.99 power factor, answer.

Problem 8. Given: an 800-hp. load at 0.77 power factor. What size of synchronous condenser or capacitor would be required to raise the power factor to 0.9?

Solution: draw the base, perpendicular, and the two lagging-power-factor slants as in Problem 1. Measure *CD* 27/16 in. = 270 hp. Multiply by 0.89* = 240 kva., answer.

*(Assumed motor efficiency, 84 per cent, that is, 0.746 ÷ 0.84 = 0.89.)



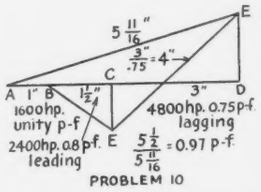


Problem 9. Given: a 2,000-hp. load at 0.8 power factor. What will be the effect of connecting 600 kva. of synchronous condensers or capacitors?

Solution: choose a scale of 1/16 in. = 25 hp. Draw a base line *AB*, 5 in. long, and a perpendicular at *B*. Divide 5 in. by 0.8 = 6¼ in. Determine a point, *C*, on the perpendicular 6¼ in. from *A* and draw *AC*. Divide 600 by 0.89 (see Problem 8) = 675. Divide 675 by 25 (the scale) = 27/16. Measure down *BC* 27/16 in. from *C* and establish point, *D*. Draw *AD;* it measures 5 7/16 in. Five inches divided by 5 7/16 = 0.92 power factor, answer.

Problem 10. Given: 1,600 hp. in unity-power-factor load, 2,400 hp. in 0.8 leading-power-factor load, and 4,800 hp. in 0.75 lagging-power-factor load. What will be the system power factor?

Solution: choose a scale of 100 hp. = 1/16 in. Draw a base line *AD*, 5½ in. long; make a mark at *B*, 1 in. from *A;* a perpendicular down from *C*, 1½ in. from *B;* and a perpendicular up from *D*. From *B*, draw an 0.8 leading - power - factor slant intersecting the perpendicular drawn from *C* at point *E*. Divide 3 in. by 0.75 = 4 in. Draw a line *EF* 4 in. long to the perpendicular over *D*. Draw and measure *AF* (5 11/16 in.). Divide 5½ in. (total load) by 5 11/16 = 0.97 power factor, answer.



Note: Where there is no power factor meter installed, the power factor of a motor, of a single circuit, or of a whole plant can be found from the reading of a wattmeter, a voltmeter, and an ammeter.

For three-phase power, watts divided by (volts times amperes times 1.73) gives the power factor.